POWER

Vol. 40 NEW YORK, DECEMBER 29, 1914 No. 26

You've Got To Make The Old Stuff Do— That Costs Too Much.
That's All Right, If You Know It Will Give Better Results.
It Costs A Little More Though
CG for POWER

ONE REASON WHY SOME PLANTS ARE MORE EFFICIENT THAN OTHERS

Power Plant of the Acme Tea Company

SYNOPSIS—In designing the power plant of the new bakery for the Acme Tea Co., Philadelphia, Penn., the primary objects were efficiency and provision against interruption to the bread-making process by failure of the power supply; the doughs must be worked within a comparatively short time. Any failure in the daily supply of bread and cake is a loss to over 250 company stores.

Practically three sources of power supply have been provided for the new bakery of the Acme Tea Co., at 25th, York and Hagert Sts., Philadelphia, Penn., two being obtained by duplicate boilers, engines and generators, and the third by an emergency service connection with the street mains of the Philadelphia Electric Co.

The steam plant is in the basement at the Hagert St. end of the main building, Fig. 1, and is so isolated as to prevent dust from coal or ashes reaching the interior of the building.

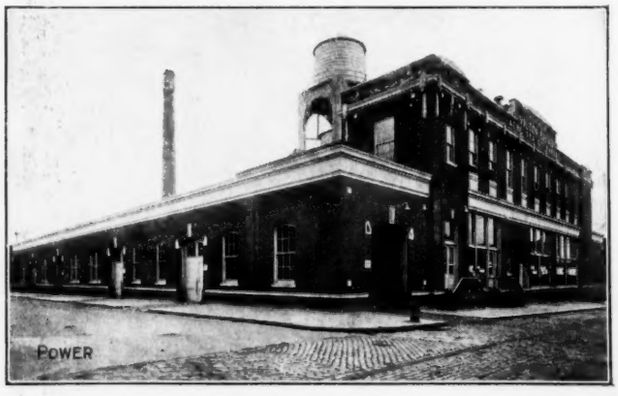


FIG. 1. BAKERY OF THE ACME TEA CO.

For the steam supply, there are two 270-hp. down-flow water-tube boilers, Fig. 2, the furnaces of which are equipped with shaking grates. Draft is provided by a radial brick chimney having an inside diameter of 54 in. at the top and a height from the boiler-room floor of 127 ft. 10 in.

Electrical power is used in the plant, except in a few instances, and is applied by individual motors for each machine wherever possible, shafting being practically eliminated. An alternating-current, 220-volt, two-phase, 60-cycle, four-wire system is used so as to switch to the break-down service without intermediary apparatus. This 220-volt current also permits the use of squirrel-cage motors, which are particularly suitable for the service because of the flour dust. The break-down service enters the building underground and is connected to independent busbars on the main switchboard; its capacity is equal to either of the two generating units.

GENERATING UNITS

For generating electrical energy there are two horizontal, center-crank, tandem-compound, direct-connected engines, with 13½-in. diameter high-pressure and 20½-in. diameter low-pressure cylinders, 16-in. stroke, running at 225 r.p.m. These engines are guaranteed to develop 202 i.hp. at the most economical point of cutoff with a steam pressure at the throttle of 125 lb., a back pressure of 3 lb. and a steam consumption at full load of 22½ lb.; three-fourths load, 23½ lb., and one-half load, 26½ lb. One-half of one per cent. regulation is guaranteed at 20 lb. above or below the normal steam pressure and one per cent. regulation from no load to full load, the engine resuming its normal speed in three revolutions.

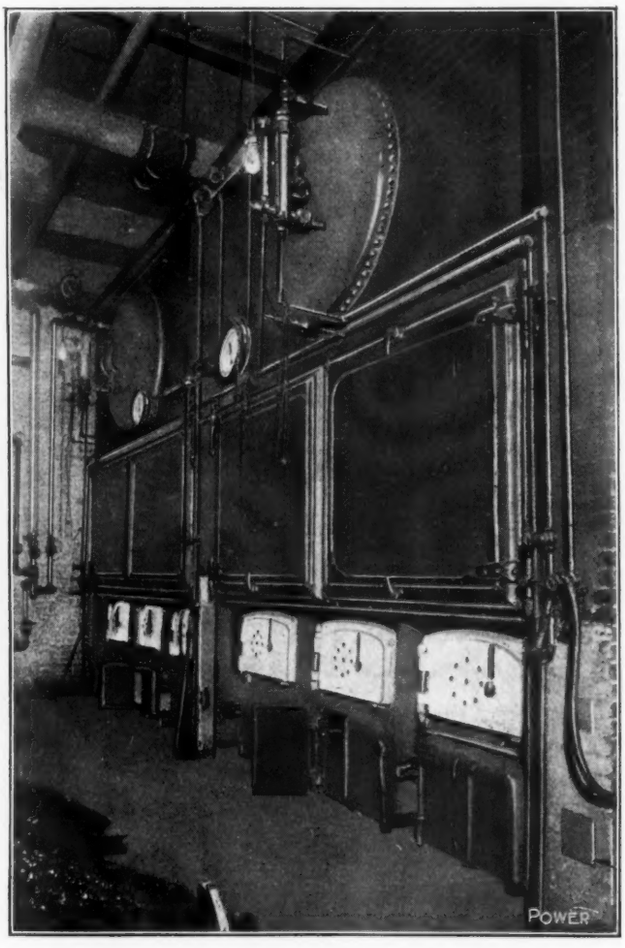


FIG. 2. THE 270-HP. DOWN-FLOW BOILERS

Direct-connected to each of these engines is a 240-volt, 60-cycle, two-phase, 30-pole, 150-kv.-a., 120-kw. at 80 per cent. power factor, engine-type, revolving-field, alternating-current generator, at 225 r.p.m. Each generator has an 8-pole, 10-kw., 125-volt, direct-connected exciter. The generators are guaranteed to have a regulation at 100 per cent. power factor of within 6 per cent. and at 80 per cent. power factor of within 20 per cent., the engine regulation being as above. The temperature rise with full load at 80 per cent. power factor is not to exceed 35 deg. C. Fig. 3 is a view of the engine room.

PIPING

The high-pressure piping system is for 125 lb. working pressure and is insulated with 85 per cent. magnesia covering. A 10-in. steam header runs above the boilers to

the engine room, from which connections are made to the several units. There is a 6-in. connection between each boiler and the header, a safety nonreturn angle valve being placed at the boiler and a gate valve at the connection to the header. In the engine room a separate connection, valved at the header, is made to each of the two high-speed engines and to the Corliss engine operating the ammonia compressor for the refrigerating system.

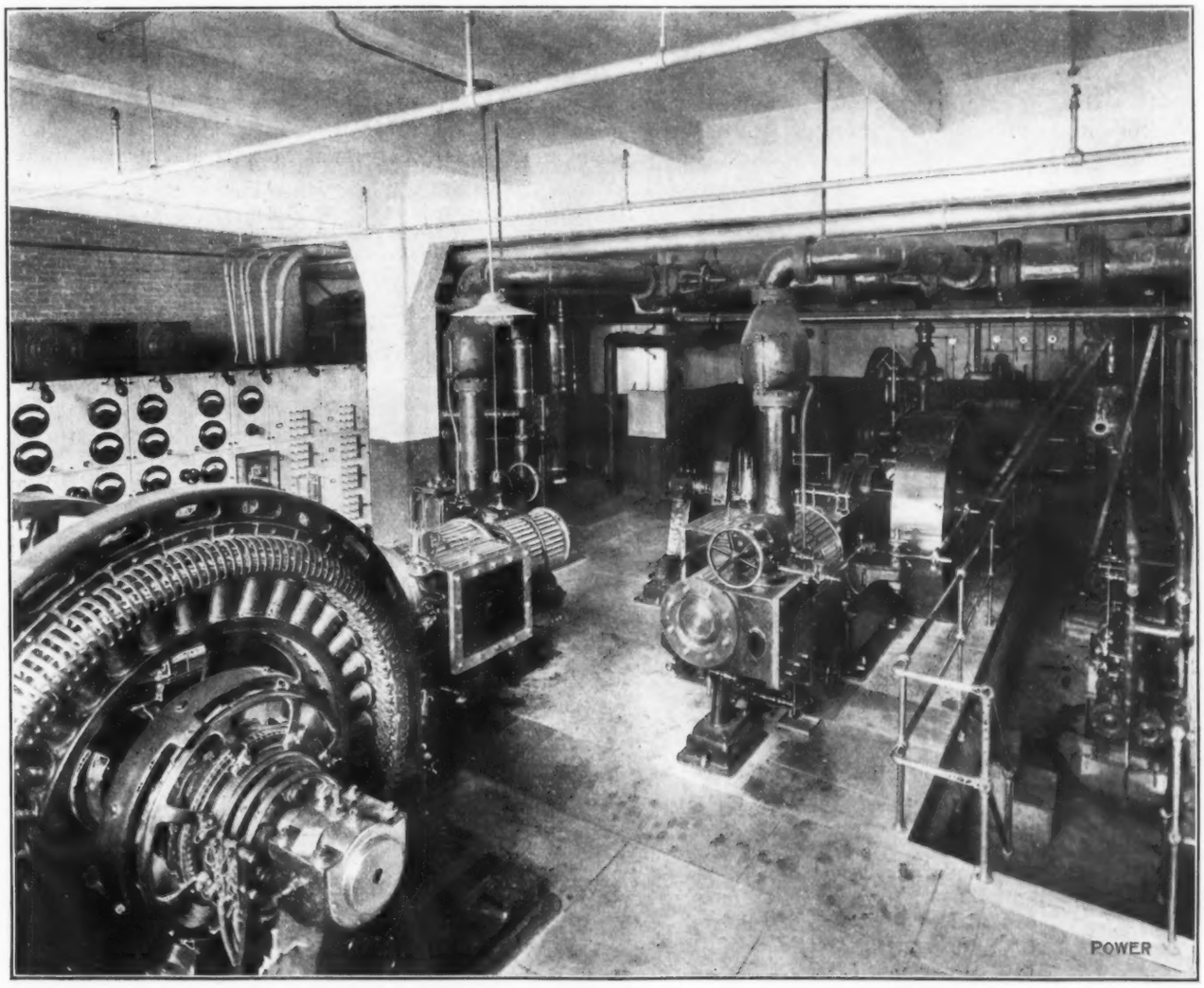


FIG. 3. VIEW OF THE ENGINE ROOM OF THE ACME TEA CO.

Branches from the header supply the deep-well pump, the Underwriters fire pump and the steam pump used for brine-circulating purposes. A 5-in. branch is also taken from this header to supply the steam-operated boiler-feed pump and also through separate reducing valves the low-pressure steam line to the ovens and humidifier. This branch also supplies any low-pressure steam required to supplement the exhaust steam for the vacuum steam-heating system. A plan of the plant and piping is shown in Fig. 4.

HEATING

Direct radiation is used for the heating system except in the mixing room; here the blower system is employed. All direct radiation is in the form of cast-iron wall radiators on the side walls and of pipe coils of manifold-header type with expansion bends on the ceiling of the cooling room and the driveway. On the return of each unit of radiation, also on the blower coils and at drip points, a thermostatic valve automatically relieves the radiators and piping of air and water of condensation and prevents the escape of steam. All returns are conveyed to a vacuum pump in the engine room and discharge through an air-separating tank to the feed-water heater. Because of the ovens, heating in the bake room would be superfluous when they are in operation, and therefore only a small amount of radiation is provided to prevent freezing when the ovens are not in service.

SWITCHING APPARATUS

For the electrical system the main switchboard of polished blue Vermont marble consists of two generator panels, a total-load panel and one light and one power feeder panel. Each generator panel has a separate voltmeter and ammeter for each of the two phases of the system and an ammeter and voltmeter for the exciter. Double-pole circuit-breakers are provided on each phase, together with a four-pole main switch, exciter and field switches and there are plug receptacles for testing for grounds and for synchronizing. The rheostats for the generators and exciters are of the concentric type. The total load panel has a power-factor indicator, voltage regulator, an equalizer rheostat for the two exciters, and two watt-hour meters, one for light and the other for power.

All of the switches on the power and lighting feeder panels are of the double-throw type and are connected to separate busbars in the rear of the board. Thus, either the break-down service or the current from the generators in the engine room can be supplied interchangeably to any feeder without interfering with the current supplied to any of the other feeders. This makes it possible for the outside current to supplement that from the generators in the engine room, or to use the outside current and that from the generators.

Cable connections from the switchboard to the generators and exciters are made through iron conduit buried in the floor and passing through the concrete foundations of the engines to the pit under the generators, where connections are made to the generator and exciter lugs.

engine room. An elevation of the pump piping is shown in Fig. 5.

The city supply has a pressure of from 40 to 44 lb. and is ordinarily sufficient to fill both the sprinkler and the house-supply tanks. A 3-in. line from the city main is brought to the pump area in the engine room, from which a 2-in. branch is extended to the house-supply and sprinkler tanks, both of which are filled at the top through a balanced tank valve automaticaly opening when the water level in the tank falls and closing against pressure when either tank is filled.

From the bottom of the house-supply tank an independent 1½-in. supply line is extended for filling the flushometer tank above the roof of the building. This water-supply is for the water-closets and urinals, thus

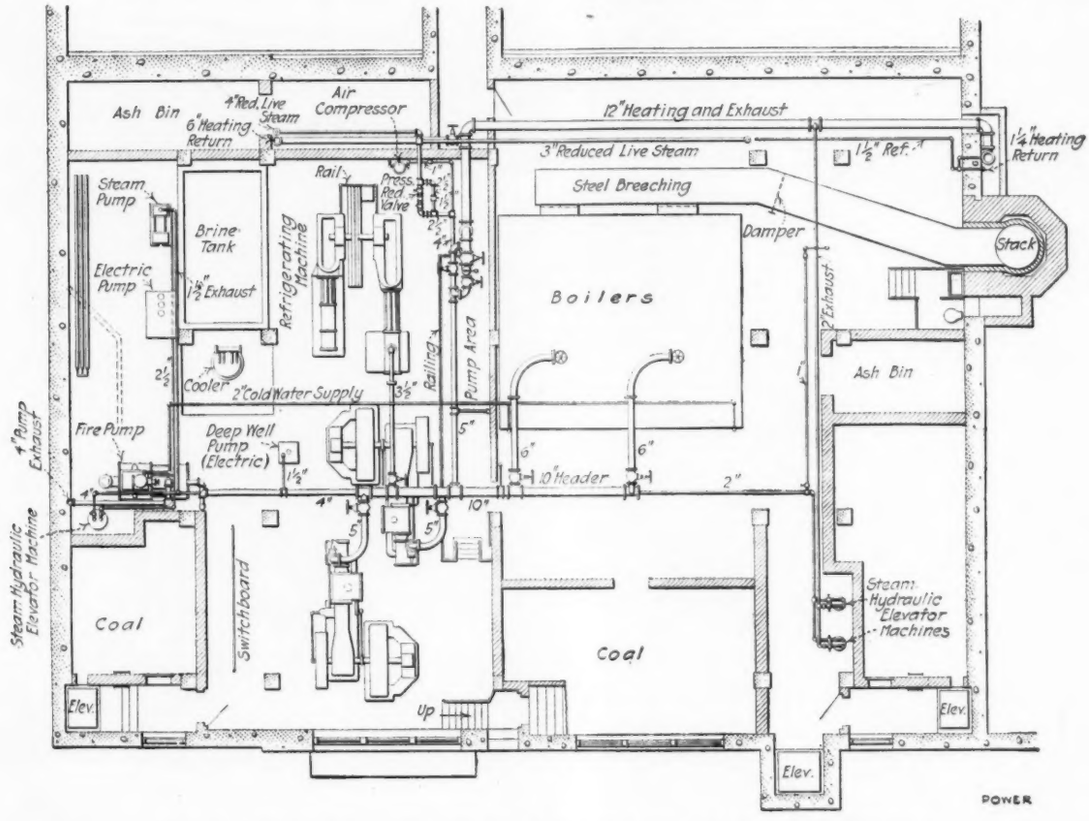


FIG 4. PLAN OF POWER PLANT SHOWING THE MAIN STEAM PIPING

The lighting system consists of five four-wire, 220-volt feeders, extended to the centers of distribution throughout the building, where the four-wire lighting panel boards have a four-pole switch at each panel board to control all the lighting on it; two-pole switches are used to supply the branch circuits.

In any room requiring more than one lighting circuit they are balanced on the two phases of the system, and in case of large rooms having several ceiling circuits, proper balance is secured by placing every alternate circuit on the same phase, the remaining circuits being on the other phase. The lighting units consist of tungsten-filament lamps in as large units as practicable for the room to be lighted.

WATER-SUPPLY

There are two sources of water-supply, one from the city main and the other from an artesian well in the

separating it from the supply to the other parts of the building.

A second independent 1½-in. drop line is taken from the bottom of the tank and extended to two filters through which all water for drinking or bread-making purposes is obtained. From the filters a 1½-in. line is carried to the preparation room in the second story, at which point two branches are taken off, one supplying an automatic brine-coil water-cooler and the other an automatic hot-water heater. Another branch from the 3-in. water-supply in the engine room supplies the boiler-feed pumps, the makeup water for the feed-water heater, the double-pipe ammonia condenser coils of the refrigerating system, the humidifying system in the dough room, and the water jackets on the dough mixers.

The artesian well, which furnishes the other sources of supply, is 8 in. in diameter, is lined with wrought-iron pipe to solid rock and has a depth of 250 ft. This well

is operated by a direct-connected, steam-driven, double-acting well pump having steam cylinder 10 in. in diameter, a well cylinder 5¾ in. and a 36-in. stroke. The water cylinder is approximately 150 ft. below the engine-room floor.

This pump has a combined check valve and air chamber and a 1½-in. pump governor attached to the steam supply and connected to the discharge. It is also provided with a relief valve discharging to the sewer through a connection open to the air. The pump is guaranteed to deliver 137 gal. of water per min. at 20 r.p.m. with a steam pressure of 70 lb. Upon test it developed a capacity of 165 gal. per min. at the speed mentioned and a capacity of 275 gal. per min. at 34 r.p.m.

The water from the well at a temperature of 56 deg. is delivered by the deep-well pump to a surge tank near the ceiling in the second story, from which tank the water goes by gravity to the humidifying system, condenser coils and feed-water heater in the order named. In the humidifier it will, in times of maximum demand in summer, be raised to not exceeding 70 deg., after which it will overflow from the humidifier and pass to the condenser coils. Even at 70 deg., this overflow water in passing through the humidifier will be cooler than the water in the city mains during the hot summer months, and will for that reason be more economical to use. Provision is also made for automatically passing direct to the condenser at its original temperature any well water not needed by the humidifier, without interference.

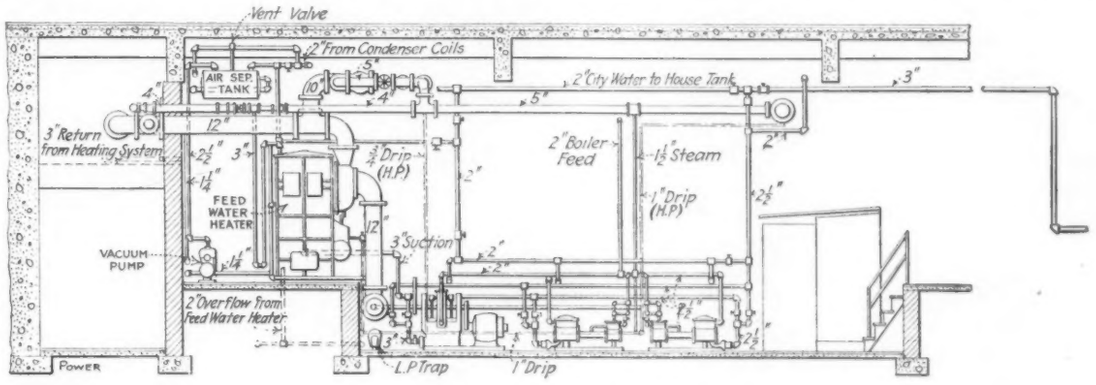


FIG. 5. PIPING OF PUMPS AND HEATER IN ELEVATION

PRINCIPAL EQUIPMENT OF THE POWER PLANT OF THE ACME TEA COMPANY

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Boilers	Parker down-flow	270 hp	Main units	One held in reserve	Parker Boiler Co.
2	Grates	McClave		Boiler furnaces	Hand shaking	McClave-Brooks Co.
1	Chimney	Radial brick	127' 10" x 54" dia.	Furnace draft	Natural draft	H. R. Heinicke
2	Engines	Skinner	13½x20½x16 in.	Main units	225 r.p.m., 125 lb. pressure	Skinner Engine Co.
2	Generators	Alternating current	150 kv.a.	Main generators	225 r.p.m., 220 volt, 2 phase, 60 cycles	
2	Generators	Direct current	10 kw.	Exciter units	125 volt. 225 r.p.m.	
2	Valves	Balanced		Tanks for house supply	Automatic	Thomas P. Ford Co.
2	Filters	Water		House water supply		Roberts Filter Mfg. Co.
1	Pump	Deep well	10x5½x36"	Pumping from deep well	Steam driven	American Well Works Co.
1	Governor	Pump		On deep well pump		Watson & McDaniel Co.
1	Compressor	Ammonia	35 ton	Refrigerating system	Steam driven	Vilter Mfg. Co.

After passing through the condenser coils the water is raised from 70 deg. or under to 95 deg. or over, and is then discharged to be used as makeup water for the feed-water heater, and raised to about 210 deg. before going to the boiler. Any of this water not required for feed water then automatically overflows to the sewer by gravity.

The discharge line from the deep-well pump is connected to the main supplying the water from the city service, with valves so arranged that the city service or the deep-well water can be used interchangeably for the building, or by the manipulation of valves the deep-well pump can supply practically any group of apparatus in the building while the city service is supplying any other group. The system has been devised for the most economical use of water from either the city service or the deep-well pump. All cooling water is conserved for use where it will be of the most advantage, so that the heat units once imparted are conserved progressively until the water is converted into steam, thus reusing the water to prevent waste.

By the cross-connection of the water-supplies these economies can be obtained either with the well or city water. If the well-water supply is short, this water can be used where most needed for cooling purposes, namely, in the humidifier and condenser coils, supplemented by city water in any other parts of the system.

REFRIGERATING SYSTEM

For the refrigerating system a 35-ton ammonia compressor is directly connected to a Corliss engine with a three-section, double-pipe, closed-type condenser. Cooling throughout the plant is performed by the circulation of calcium brine to the cold-storage room in the basement, to the refrigerator in the second story, the water cooler in the preparation room, and to supplement the well-water supply to the humidifier in the mixing room in excessively hot weather. A brine cooler and one steam pump and one electrically driven brine-circulating pump are in the basement. There is a brine-storage tank to give a reserve capacity and render unnecessary the continuous operation of the refrigeration system and to afford opportunity for changes or repairs.

SPRINKLER SYSTEM

For fire-protection, a 30,000-gal. sprinkler tank 30 ft. above the roof supplies the automatic sprinklers on the wet-pipe system except in the wagon shed, where, owing to the possibility of freezing, the dry-pipe system is used. A 1000-gal. Underwriters steam fire pump piped to the city water mains supplements the gravity tank

in supplying the sprinkler system. A feature of the piping in the bake room is that of running the sprinkler mains through the deep girders by means of pipe sleeves put in the forms before the concrete was poured, thus permitting both mains and branches to be placed near the ceiling and neither form an obstruction nor mar the finished appearance of the room.

A steam-driven air compressor maintains the pressure on the dry-pipe sprinklers and is also utilized in connection with an air-storage tank for supplying compressed air to outlets throughout the building for blowing flour dust from the motors and other machines.

Both the design of the building and the installation of the complete mechanical equipment were in charge of the architectural, structural and mechanical departments of Ballinger & Perrot, Philadelphia, Penn.

Things of Interest in Recent Turbine Design

SYNOPSIS—Considers the most important of those changes in design and materials that have developed large turbines.

Large Turbines in Land Practice

At the Stuart St. station of the Manchester (Eng.) Corporation, a Zoelly impulse-type turbine driving a Siemens alternator of 15,000-kw. capacity has recently been installed. The New York Edison Co. has a 30,000-hp. Curtis unit at its Waterside Station, New York City. The Interborough Rapid Transit Co., of the same place, will have three Westinghouse turbines of 30,000 kw. each. Each unit is divided into two sets mechanically independent of each other, but as a heat engine the unit of two rotary elements must be regarded as one machine. The Kommunale Elektrizitätswerke at Hagen, Germany, has installed a Brown-Boveri turbo-alternator giving a maximum output of 25,000 kw. at 11,000 volts. The Philadelphia Electric Co. has put in two horizontal turbo-generators, one of 30,000 kw., 25 cycles, the other of 35,000 kw. and furnishing current at 60 cycles. These examples illustrate the enormous capacities which have now been obtained in steam-turbine land practice.

Marine Turbines of Large Capacities

At sea, large steam turbines are being introduced. In a paper which Sir Charles A. Parsons read in March, 1913, before the Institution of Naval Architects, summarized in *International Marine Engineering,* June, 1913, he pointed out that there were in service cargo steamers, channel steamers and warships about 26,000 hp. developed by steam turbine and transmitted through mechanical gearing. At the time when he gave this lecture, there were under construction turbine machinery and mechanical gearing representing a transmission of over 120,000 hp., including two installations of over 20,000 hp. each. In other large vessels the efficiency of the steam installation is due chiefly to combining exhaust-steam turbines with large-capacity reciprocating engines. Harland & Wolff, Ltd., have specialized on this combination of propelling machinery, and in the White Star liner "Britannic," for example, the steam drawn from the exhaust of the reciprocating engine passes at about 10-lb. pressure into an exhaust-steam turbine which develops 18,000 hp. The "Aquitania," built by John Brown & Co., Ltd., of Clydebank, is propelled by Parsons turbines, arranged on a triple-expansion system and driving four propellers, the total horsepower being 56,000. The introduction of the steam turbine has been made extensively in battleship design and T. G. Owens, of Vickers, Ltd., in a paper read recently at the Institution of Naval Architects, England, on "Questions Relating to Battleship Design," as reported in the engineering supplement of the London *Times,* stated that whereas the power obtained on predreadnaught vessels was 10.2 i.hp. per ton of machinery, the shaft horsepower obtained per ton in the earliest turbine-driven battleships was 12.25 to 13.75.

The increase of efficiency in large power units is a marked property of the steam turbine, and since, as compared with other forms of prime movers, the boiler and steam turbine unit does not, perhaps, stand highest in thermal efficiency, the increase in efficiency obtained by the increase in size of the unit is of importance.

One of the main reasons why the steam turbine has obtained such wide application as compared with other forms of units is that while as contrasted, say, with an internal-combustion engine, the thermal efficiency of the whole plant may be slightly lower, standing charges on the initial cost of the turbine plant are low and the cost of maintenance and supervision is low. Both of these factors are dependent on the simplicity of turbine design and construction.

Performances of Some Large Turbines

To show the performances obtained with large steam turbines, figures given by the *Electrical Review* of London for the Brown-Boveri turbine referred to may be mentioned. When working with steam at 350 deg. C (662 deg. F.) and 13.5 atmospheres (200 lb. pressure) and at 1000 r.p.m. this machine has a guaranteed steam consumption of 5.2 kg. (11.46 lb.) per kilowatt-hour at normal load; 5.43 kg. (11.97 lb.) at three-quarter load; 5.85 kg. (12.89 lb.) at half load. The 30,000-kw. Philadelphia turbine is supplied with steam at 215 lb. pressure at the throttle, superheat not exceeding 200 deg. F., and back pressure not exceeding 1½ in. of mercury. This is guaranteed for 12.45 lb. per kilowatt-hour at 15,000 kw., 11.9 lb. at 22,500 kw., and 12.75 lb. at 30,000 kw. The 35,000-kw. machine is guaranteed under the same conditions for 12.9 lb. of steam at 15,000 kw., 11.9 lb. at 25,000 kw., 12 lb. at 30,000 kw., and 12.6 lb. at 35,000 kw. Considering a smaller machine, the 15,000-kw. set at Manchester (see *Electrical Review,* London, July 3, 1914) with 190 lb. pressure steam at a total temperature of 530 deg. F., 27½-in. vacuum and power factor of 0.95, is guaranteed for 16.95 lb. of steam at quarter load, 14.92 lb. at half load, 14.12 lb. at three-quarter load, 13.65 lb. at full load, and 14.25 lb. at 25 per cent. overload.

Floor Space Needed by Large Turbines

One of the noteworthy features of modern turbine design is the economy of space. In the case of the turbo-

generator sets installed for the Interborough Rapid Transit Co., the necessary space was obtained by clearing out four engine-driven sets of the slow-speed Corliss type which had a combined capacity of only 28,000 kw. Each of the old sets had two horizontal high-pressure cylinders, each 44 in. diameter, and two vertical low-pressure cylinders, each 88 in. diameter with a common stroke of 60 in. The total capacity to be put in the same space is 90,000 kw. for the turbines. The 25,000-kw. turbo-alternator at Hagen occupies a floor space of 16x4.2 meters (722.78 sq.ft.), this being the equivalent of a floor space of 0.029 sq.ft. per kilowatt of capacity.

Vertical turbines have been largely installed, but, as pointed out by R. F. Halliwell in a paper before the Manchester Association of Engineers (see *Vulcan*, September, 1913), although the vertical-shaft arrangement was satisfactory in running, it was found that for large units an excessive amount of head room was necessary. The horizontal arrangement presents advantages in accessibility and the more favorable position of the generator. In some places where space was costly, it has been found advantageous with reaction turbines to combine an impulse element to save length on the turbine, as pointed out by A. Q. Carnegie in the discusssion on a paper by W. C. Mountain, before the North of England Institute of Mining & Mechanical Engineers. Mr. Carnegie also pointed out (see *Iron & Coal Trades Review*, London, Aug. 7, 1914) that whereas Mr. Mountain had mentioned that the present makers of the Parsons turbine almost invariably fitted the Curtis or impulse wheel in the high-pressure stage of the mixed turbine, where economy was of the first importance, the pure reaction design must of necessity be adopted because the efficiency of reaction blading is considerably higher than that of the simple impulse or the velocity-compounded turbine.

The high speed of the turbine assists greatly in reducing the floor area required per unit of power delivered. Dr. C. P. Steinmetz, writing recently in the *General Electric Review* on the subject of energy density, points out that the highest velocities in rotating machinery are reached in the revolving rim of the steam-turbine disk, approaching 200 meters (356 ft.) per second and representing the stored energy of 5.6 watt-hours per kilogram (1 kilogram = 2.204 lb.) of rim weight. This has involved careful design to secure the use of suitable materials and proper construction to avoid damage under the severe conditions.

The exposure of the wheel to the action of superheated steam simultaneously with high stresses is a condition which requires careful choice of material. From a note in the *Iron & Coal Trades Review* recently, it appears that wrought iron has been found suitable for superheated-steam turbines. The tensile strength at 932 deg. F. falls from 52,600 lb. to 18,400 lb. But according to Rudeloff, at 400 deg. C. (752 deg. F.) it has a tensile strength of 45,000 lb. and an elongation of 40 per cent. and is used for blades in the Thyssen, the Melms and Pfenninger turbines. Although ordinary bronzes have not been satisfactory and pure nickel cannot be used on account of its fragility at high temperatures, special bronzes have given good results and tests at the laboratory of the Hungarian Royal Iron & Steel Works show that at high temperatures low-carbon steel is superior to high-carbon. Guillet, on the basis of extensive tests, recommends for blades steel of 30 to 32 per cent. nickel and a maximum of 0.12 per cent. carbon. The coefficient of expansion of this steel is small and it does not rust in clean water.

The troubles which were formerly anticipated by the whipping of long shafts at high speeds have been overcome. In the discussion before the Mining Institute it was pointed out that at present shaft deflections and whirling speeds are calculated so as to avoid whirling and blade stripping. In low-speed Parsons reaction turbines the running speed is always lower than the first critical speed, while in high-speed turbines it is kept clear of the nearest of these speeds. That the shaft may run safely through the critical points the bearings are provided with concentric oil cushion tubes to damp out vibration. Mr. Carnegie referred to another point of mechanical construction which marks a distinct advance, that of end tightening the blades. Both the cylinder and spindle being arranged with shrouding strips, fine clearances are possible with safety owing to these clearances being adjustable in an axial direction, the shaft being free to move laterally without risk of making contact on the blading.

In the Ljungstrom turbine, to which reference will be made shortly, troubles from unequal expansion distortion are claimed to be less than with turbines of the cylindrical type. Even so, special features are introduced in the design to reduce such troubles to a minimum. For example, the blade rings are connected to the disks by thin conical rings of bulb-headed section to give a rigid drive and firm support to the ring and to allow for small changes of diameter.

Other mechanical properties which have received attention are the design of thrust bearings or alternative means of balancing end thrust. An interesting arrangement recently brought out by Sir C. A. Parsons (*Vulcan*, May, 1914), more particularly in connection with turbines for marine purposes, removes the danger of corrosion of the rotors, blades and other parts by interposing a strainer made of the same metals as the parts of the turbine subject to corrosion. If the steam carries corrosive agents they will attack this strainer and become chemically inactive before they reach the working parts of the turbine.

In marine practice the task of designing a propeller whose best performance would be given at the speeds required by a turbine driving it directly was a difficult problem, but a practical solution has been found in the introduction of speed-reducing devices of various types, while on land, particularly in connection with electrical installations, the direct coupling of dynamos and alternators to the turbine, although successfully accomplished, requires special means of clamping the rotor windings, the commutator, etc., to resist the high centrifugal force.

One form of turbine reduction gear, as made by the Westinghouse Machine Co., has a floating frame carrying a double helical pinion, which is able to adjust itself and allow the pinion to assume a deflection in accordance with any load which is being transmitted. This enables the tooth pressure to be equally distributed across the whole working face of the gear. Special oiling arrangements are provided and oil actuates floating frame pistons regulating the amount of movement which this floating frame takes. Incidentally, this arrangement makes it possible to quickly determine the shaft horse-

power transmitted. This type of gear was installed on the United States naval collier "Neptune." Geared turbines have also been fitted in connection with British vessels as described in the paper before the Institute of Naval Architects by Sir C. A. Parsons. The efficiency of this arrangement is, of course, determined by the efficiency of the modern helical gear, which is high.

An alternative system of speed reduction is that developed by Dr. Fottinger, in which the hydraulic pressure is created by a water turbine mounted on the steam-turbine shaft; this hydraulic pressure drives a second water turbine on the propeller shaft. The system has been applied extensively in marine practice. It is stated that the efficiency of the system can be brought up to 91 per cent. Another system of speed reduction is electrical. The United States Government collier "Jupiter" has a turbo-electric-generating unit of the three-phase type giving about 5000 kw., 2300 volts at 2000 r.p.m., while the two propeller shafts each have an induction motor running at 110 r.p.m., the ratio of speed reduction, 18 to 1 (disregarding slip of the motors), being accomplished with excellent efficiency, considering the double conversion from mechanical to electrical and back from electrical to mechanical power. Full particulars of this installation are contained in *International Marine Engineering* of August, 1913. In Great Britain considerable work has been done in the same general direction by S. A. Mayor. A point with regard to the interposition of electrical apparatus of this kind is that it gives a simple method of reversing the propeller.

On land the problem of speed reduction is perhaps not so pressing and yet cases arise where it is convenient to utilize a slower speed than that given directly by a turbine. For example, it is of undoubted advantage in direct-current electric plants to run at moderate speed rather than the high speeds required by some types of turbines. An interesting method by means of which the inherent high speed of the turbines is reduced in a simple and practical manner to the medium speed most convenient for some forms of electric machinery drive is given in the Ljungstrom turbine, which is manufactured in Great Britain by the British Electrical Co., Ltd., of Loughborough. This consists of a nest of rings placed concentrically to one another, each ring being composed of horizontal turbine blades. The alternate rings are connected to a fixture at opposite ends so that rings connected to one fixture intermesh with the rings connected to the other. Each system of blades is connected to a separate shaft. Steam is admitted at the center of the arrangement and passes outward radially; thus the sets of rings of blades react on one another. If the loads on the two shafts are equal, these shafts turn at an equal speed in opposite directions. To the end of each of these shafts is connected an electric generator and arrangements are made to connect these generators together electrically so that the load on each is kept the same. In this way the speed of the generator is reduced to half the speed of the blades with relation to one another. A description of the Ljungstrom turbine will be found in *Engineering*, London, for April 12 and 19, 1912.

The concentration of a large amount of power in one prime mover has brought with it the problems of supplying sufficient steam for each turbine set, resulting in changes in the design of boiler houses and a remarkable development of auxiliary apparatus.

Smoke Recorder and Monitor

By W. W. Strong

The smoke recorder and monitor here described is planned to give an instantaneous record or warning that unburned hydrocarbon vapors are being emitted from the stack. With its aid the fireman may quickly make correct adjustments to the furnace. An illuminated set of directions for properly firing the given furnace and telling just how to prevent making smoke can be placed near the furnace door.

This type of recorder and monitor operates electrically, and is therefore almost instantaneous. The basic part of the apparatus is a small transformer using the energy of an ordinary electric lamp. The efficiency and dependability of the transformer are well known. Of course, these instruments must be essentially as efficient and dependable in their action as the transformer.

The action of the recorder and monitor depends upon the variable conductivity of the flue gases accordingly as more or less smoke is present in them. When the smoke is dense the conductivity is small, whereas the transparent flue gases from a furnace are comparatively good conductors. In the stack there is a gap in the high-tension circuit of the transformer and there are gaps in the circuit leading to a condenser; all are in parallel. When there is smoke the condenser is charged and this closes an electric circuit and operates a watch or recording clock. When there is no smoke the discharge occurs in the stack and nothing happens. By changing the length of the gaps the recorder may be made to record almost any density of smoke or fumes; for example, No. 2 of the Ringlemann scale.

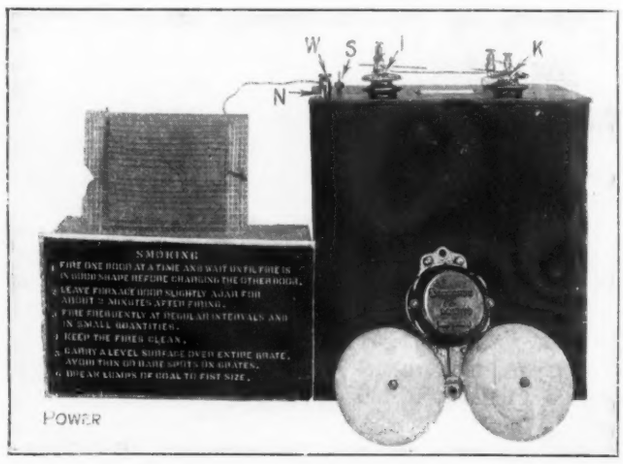


Fig. 1. Firing Directions on the Smoke Monitor-Recorder

The Smoke Monitor

Fig. 1 and the right portion of Fig. 2 show smoke monitors, the one in Fig. 2 being portable. This apparatus rings a bell and illuminates a sign when the stack is disobeying the city ordinance by emitting dense smoke. The directions are drawn for the particular stack so that by following them the fireman can obtain as nearly a smokeless stack as is possible with a maximum efficiency. In Fig. 1 these directions are for a hand-fired plant. The directions can be made to apply to a mechanical stoker just as well. In the above case these directions are:

1. Fire one door at a time and wait until the fire is in good shape before charging the other door.
2. Leave the furnace door slightly ajar for about two minutes after firing.
3. Fire frequently, at regular intervals and in small quantities.

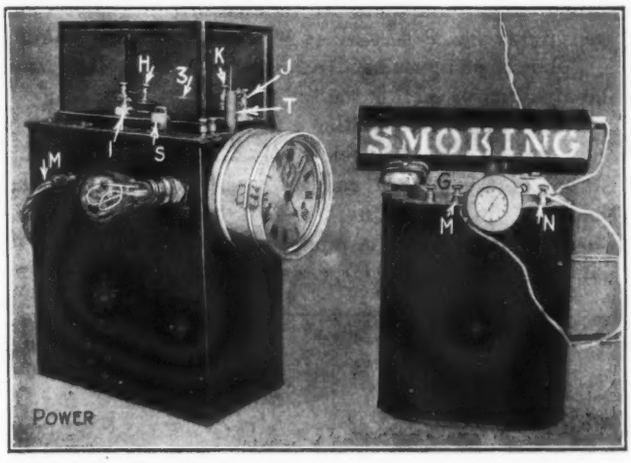


FIG. 2. ANOTHER TYPE OF MONITOR

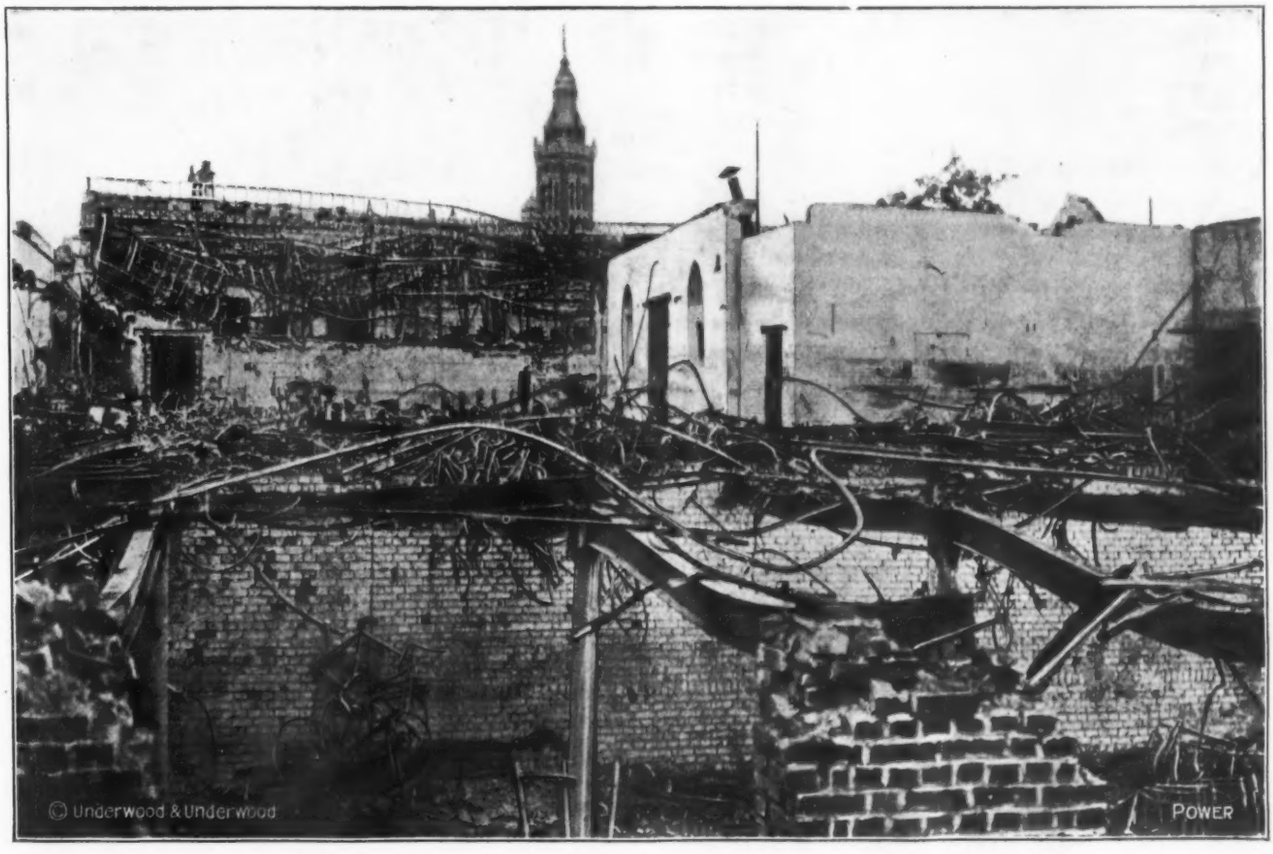
4. Keep the fires clean.
5. Carry a level surface over the entire grate. Avoid thin or bare spots on grates.
6. Break lumps of coal to fist size.

In Fig. 2 is shown a smoke recorder on the left and a portable smoke recorder and monitor on the right. In one case an engine-room clock is used to add the total time that the stack smokes, the clock going only when the smoke exceeds a certain density, say, No. 2 on the Ringlemann scale. *I* and *K* are the high-tension terminals of the transformer; *M* and *N* are the low-tension terminals, to be connected to any alternating-current lamp socket; *S* is a rod holding a spring which adjusts the tension on one of the condenser plates. This is practically the only adjustment that it is necessary to make, the tension being decreased as the contact points gradually wear away. In the case of the recorder there are no contact points; in fact, there is nothing except the clock to wear out. A graphic recorder can be made to operate in the same way.

The smoke monitors and recorders are simple instruments containing practically no moving parts, using little electric current and no chemicals and act instantly and continuously. They can be easily covered with a case so that no one can come in contact with the high-tension parts without lifting the case, and this breaks the primary current at *S*.

Manufacturing Plant Wrecked by Shell Fire

The illustration shows the ruins of the Rochet-Schneider motor works at Albert, France, after bombardment. This complete demolition evidently was not caused by solid shot, but by shells designed to cause fire. In engineering parlance they seem to have been 100 per cent. efficient in destruction. The output of these works is probably the best known in this country of any of the foreign-made gasoline motors and motor vehicles. The copyrighted photograph was obtained by courtesy of Underwood & Underwood.



RUINS OF THE ROCHET-SCHNEIDER MOTOR WORKS AT ALBERT, FRANCE

Equipment and Methods in Largest Refrigeration System—IV

By Charles H. Bromley

SYNOPSIS—Why one of the large brine pumps runs at 80 r.p.m. without causing surging in the line. Metallic packing is used for the plungers of the large brine pumps. Interesting provisions for preventing corrosion of the brine-pump plunger. The specific gravity of the brine is changed for the winter and summer months.

Other Practice at Sargent's Wharf

This, the fourth article of the series, treats of the miscellaneous practice at the Sargent's Wharf plant of the Quincy Market, Cold Storage & Warehouse Co., Boston, Mass. When a pump is forcing considerably over 10,000,000 gal. of brine per day directly into a system having an aggregate of over five miles of piping and 800 separate refrigerating services—and to do this, the pump must be run as high as from 65 to 80 r.p.m.—there must be no surging of the brine if the pump is to remain in good condition and leaks are to be prevented in the system. The pump, Fig. 16, is able to run at these and even higher speeds because at no time do streams running in different or opposing directions meet each other until the direction of each is the same.

All of the pot-type suction chambers communicate with one another, and their relative location is such that the bottom of the suction end practically forms a circular chamber. Should surging begin in the suction, the brine, when it surges into the pump, would tend to "chase itself" around the circular chamber under the valve and plungers. Wherever there is likelihood of shock due to sudden stoppage of flow or change in direction of flow—as, for example, where the suction comes to the pump at right angles from below the pump—large air chambers have been provided, their center lines being a continuation of a center line dropped through the vertical length of suction pipe.

As the brine leaves the discharge chambers on its way

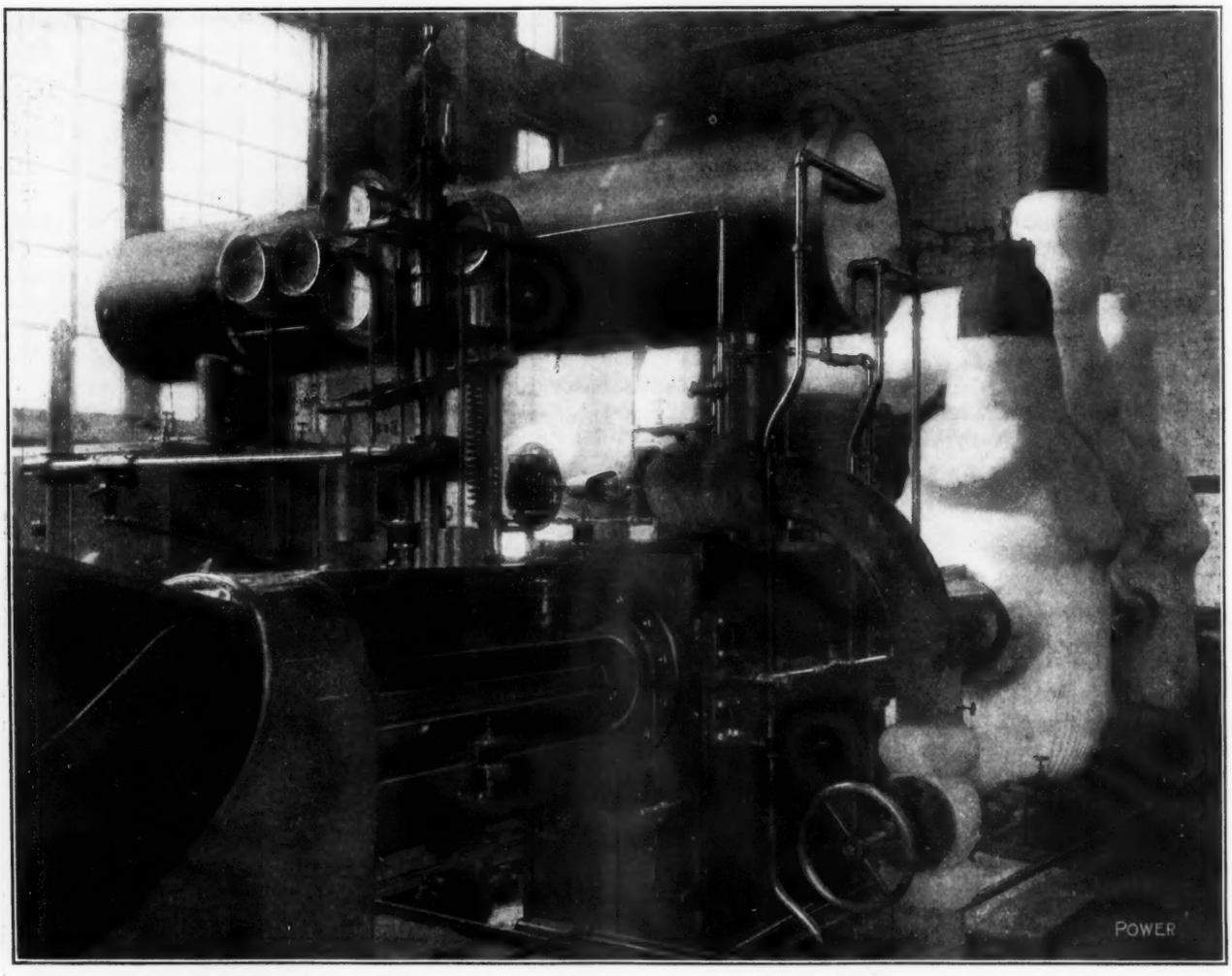


Fig. 16. This Is Believed to Be the Largest Brine Pump in Use

This pump is capable of handling 10,000,000 gal. of brine every 24 hr., and may be run quietly at the unusually high speed (for a pump so large) of 70 to 80 r.p.m.

to the main discharge line, opposing streams from each side of the pump are deflected by a baffle placed in the special tee fittings which direct these two streams into the discharge pipe. In this fitting is a baffle which conforms in shape to that of the tee. The baffle forms two nozzles in the discharge line which so converge that the velocity of the water through the nozzle, or rather at the end of it, will counteract any surging that may tend to be created. Each air chamber is provided with a

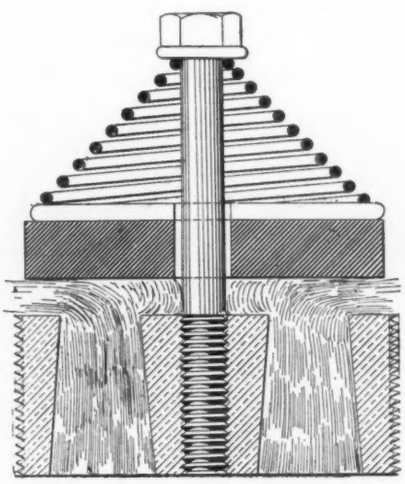


FIG. 17.

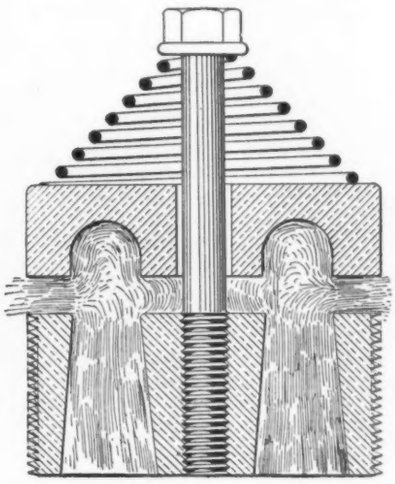


FIG. 18.

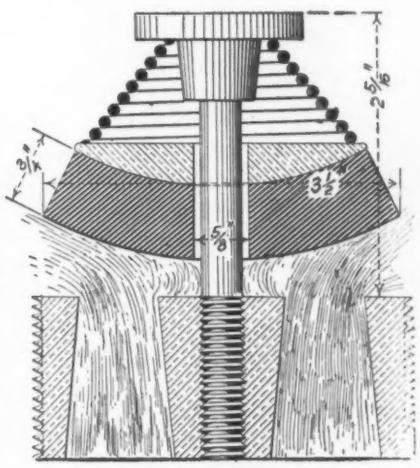


FIG. 19.

FLOW OF WATER UNDER PUMP VALVES OF DIFFERENT DESIGNS

Fig. 17—Water Deflected at Right Angles to Flow. Fig. 18—Water Reacting Back on Itself. Fig. 19—Valve used at Sargent's Wharf; Soft Rubber Disk, Giving Gradual Change in Direction of Flow.

gage glass which shows the amount the brine surges. The pump was running at more than 65 r.p.m. when the writer saw it, and the columns of water in the glasses did not move more than ¼ in. in any glass.

THE BRINE-PUMP VALVE

All pump valves except for the condenser and hot-water pumps are of standard design and size and are interchangeable. There are about a thousand of these, one of which is shown in Fig. 19. The disk or valve is of soft rubber and the saucer form of plate is adapted for use with it, so that the direction of flow of the water would have to be changed as little as possible. With a flat valve the water comes up under it and is directed at right angles as shown in Fig. 17, and with other types of valves, much water comes up under them and, due to the shape of the latter, is directed down against itself, just as in a Pelton bucket, thus offering considerable resistance to its flow. The action is shown in Fig. 18. Despite the fact that in America this type of pump valve is used but little and that some authorities on pumps claim that they have little advantage over other valves, experience with many kinds at the Sargent's Wharf plant shows that the pump will give an appreciably greater capacity with these than with other types.

PUMP PLUNGERS CORRODE RAPIDLY

The pump plungers are of cast iron and are provided with metal packing, with just enough leakage allowed to obtain the necessary lubrication. This packing is of the company's own make and consists of 25 per cent. tin, 73 per cent. lead, and 2 per cent. antimony. It is made in rectangular form, and the rings are put in as shown in Fig. 20, which illustrates a section of a packed stuffing-box. As the gland is filled up, the projections begin forcing the other part of the ring against the 11-in. plunger.

It has been found that if the pump is stopped and the film of brine on the plunger dries off, corrosion begins almost immediately. The exposed part of the plunger can be wiped and cleaned, but that part under the gland retains the little pieces of rust which, after being wiped across the face of the packing, cut it enough to be objectionable.

To remedy this trouble, a split sleeve of cast iron will be made which will fit into the stuffing box and be in two parts with flanges midway between the two stuffing-boxes. Preparatory to putting on the sleeve, a ring or two of packing will be put into each stuffing-box; the flanges covering the plunger will be provided with bolts and nuts for pushing each half of the sleeve into its

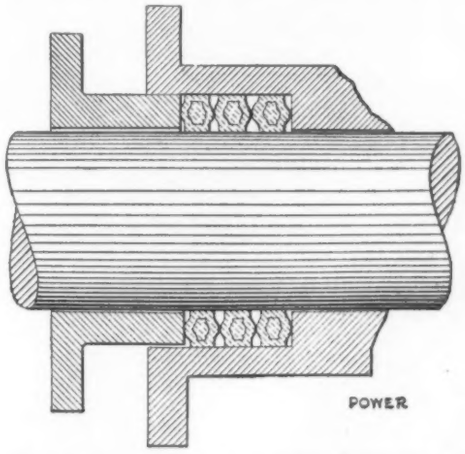


FIG. 20. SECTION OF STUFFING-BOX OF LARGE BRINE PUMP, SHOWING METALLIC PACKING

respective stuffing-box until the leakage of brine at either stuffing-box is as desired. The glands now used will be dispensed with. A water-tight cover is put over the flanges so that the entire plunger is inclosed. A plug

could be put into the sleeve to show the amount of leakage to readily determine if the sleeve sections should be screwed further apart and the packing tightened in the stuffing-box. The sleeve is, of course, cut away so that it does not touch the plunger. With the plungers provided, there will be no corrosion of the plungers when the pump is shut down, for the reason that they will be inclosed in brine, no air being able to get to them.

While either of the pumping engines used for street service may be operated on warehouse service, a two-stage, motor-driven centrifugal pump of 1000 gal. capacity is provided for the latter. The specific gravity of the brine for the warehouse system runs between 1.225 and 1.230 and that for the street system is kept at between 1.190 to 1.200. The make-up brine tank carries brine of 1.240 specific gravity and the brine for both the street and the warehouse system is "built up" by this brine. If too much is run into the street system, the operator opens the city water line into the brine circulating pump to bring down the specific gravity. It is the practice to drop the specific gravity of the brine to about 1.190 during the winter and spring, especially in the spring when the frost comes out of the ground, for it is at this time that bad breaks occur in the street piping, so that with the reduced specific gravity of the brine, the amount of calcium lost for a given amount of leakage is much less than it would be if the brine were of 1.200 or more specific gravity.

Formerly the main brine tank for the street system was on the discharge line and in the highest point in the system. This held the capacity down to that afforded by a pressure equal to the head from the tank; it also gave rise to troubles due to air becoming pocketed in the system, which, of course, further reduced the capacity. The air, it is believed, entered the system at a joint where the pressure in the pipe line from the pump was maximum and between this point and that at which the brine from the tank dropped to the minimum line pressure; some portion of the system was evidently under vacuum notwithstanding that there was a pressure of over 90 lb.. indicated by the gage on the discharge line at the pump, and over 2 lb. on the suction line at the pump. This condition also gave rise to shocks in the line at the pump, because if the pump speed were increased, as on an urgent demand, the plungers would run away from the brine on the suction side. By putting the tank on the suction side, it increased the capacity of the street system without installing larger pipe, proportionate to whatever pressure the pipes would safely carry. Also, with the 40 lb. head pressure from the tank on the suction and with the discharge pressure increased to 102 lb., the entire system was under a pressure so much above atmospheric that the air troubles immediately ceased; also the troubles from shock were avoided because the pumps do not now run away from the brine.

Formerly, the usual practice of purchasing calcium in the 600-lb. tin-closed case was followed, but now this is not the case for it takes about ten days from the time the case arrives until it is unpacked and the calcium broken and dissolved, all of which means much labor. The calcium is now purchased in solution form and brought to the plant in 8000-gal. tank cars which are put on a siding; hose is attached to the tank and in thirty minutes the brine is in the make-up brine tank. This means a total saving of about $8 per ton over importing the solid calcium, as was done when the tariff on this chemical went off.

The fifth and last article of the series will treat of more of the interesting practice at Sargent's Wharf.

Electrical Long-Distance Transmitting, Indicating and Recording System

A system for electrically transmitting long-distance readings of indicating and recording instruments has been placed on the market by the Bristol Co., Waterbury,

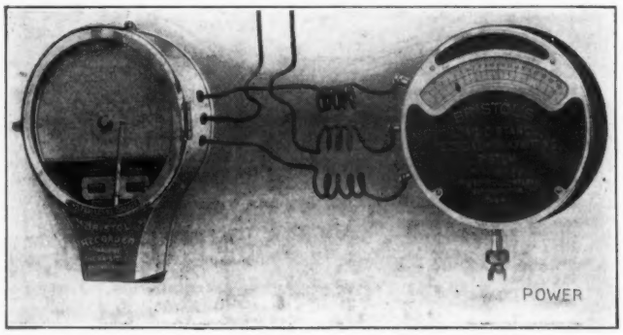


FIG. 1. BRISTOL TRANSMITTING INDICATOR AND RECEIVING RECORDER

Conn. Standard Bristol instruments are used having long-distance induction balance movements developed for this purpose by the Sangamo Electric Co. These instru-

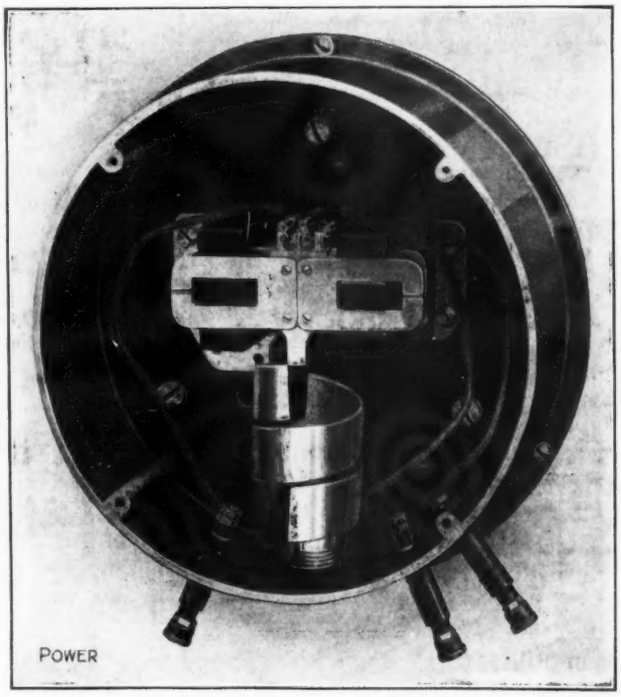


FIG. 2. INTERIOR VIEW OF THE TRANSMITTING INSTRUMENT

ments are intended to give automatic and continuous records of pressures, liquid levels, temperatures, mechanical motions, etc., up to 30 or 40 miles from the points at which the transmitters are located.

Fig. 1 shows a transmitting indicator for placing where

the pressure or temperature, etc., is measured, and the receiving recorder which is at the remote point where the record is to be produced. The only restriction to the distance is the size of wire used and the voltage.

The two instruments are connected by three wires, one of which is connected to a source of alternating current, as, for instance, a lighting circuit. The transmitting device is mounted in a moistureproof case and can be put outdoors if necessary.

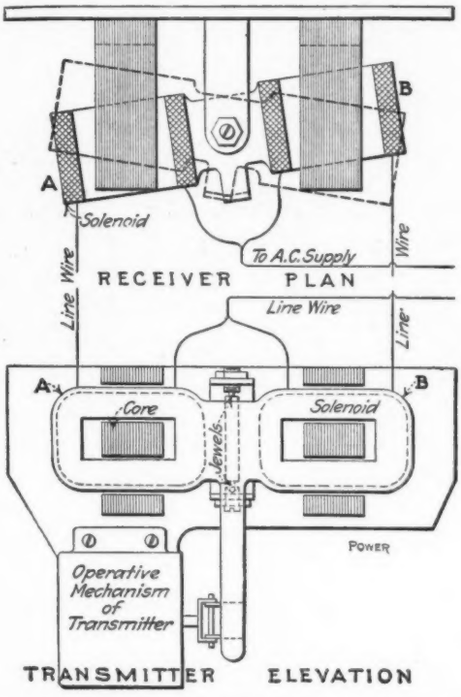


FIG. 3. DIAGRAM OF TRANSMITTING AND RECEIVING APPARATUS

The fundamental principle of the system is that of the induction balance. The transmitting and receiving instruments are each equipped with two pairs of coils arranged to swing in a horizontal plane over iron cores. Fig. 2 shows the interior of one of the transmitting instruments. The helical pressure tube and the electrical transmitting device are shown in the operating position.

Fig. 3 is a detailed front and top outline diagram of the transmitting device, which is similar to the receiving device. The outfit consists of two pairs of mechanically balanced solenoids arranged to swing horizontally back and forth over the ends of soft-iron cores and connected in parallel to an alternating-current circuit. One pair of the solenoids is used for the transmitting instrument, the other for the receiving instrument. The bottom view of the transmitter shows one pair of the solenoids *A* and *B* on spools connected and supported on a shaft, the ends of which rest in jewel bearings and are free to swing back and forth over laminated soft-iron cores. The top view shows the solenoids *A* and *B* of the transmitter in section; the dotted outlines indicate the position to which the solenoids may swing.

A similar pair of balanced solenoids is placed in the receiving recorder or indicator at the distant point. When the solenoids *A* and *B* of the transmitter and receiver are connected in parallel to an alternating-current circuit and the transmitter coils *A* and *B* are held in a certain position by the operating mechanism located correspondingly to the water-level gage, pressure gage, thermometer, etc., the relative amounts of current flowing in the solenoids *A* and *B* will depend on their positions on the iron cores, due to the inductive effect.

At the receiving instrument the other pair of solenoids is mechanically balanced and free to take an angular position, which will be the same as that of the transmitter since the flow of current will be the same in the corresponding solenoids of the receiver as in the transmitter. If the angular position of the pair of solenoids at the transmitter is changed by the operating mechanism, thus moving one of the solenoids off and the other on to the iron cores, increasing the inductance in one solenoid and diminishing it in the other, the flow of current will be proportionately increased in one coil and diminished in the other. The variations of current at the distant receiver will correspond with the variations at the transmitter and cause the pair of solenoids of the receiver to seek a position of balance which will be the same as that of the solenoids of the transmitter.

In the transmitter the operating mechanism is linked to the balanced solenoids by an arm between the solenoids *A* and *B*. In the receiver the recording pen or the indicating pointer is connected to a similar arm through a multiplying mechanism.

Various combinations of transmitting and receiving instruments of either indicating or continuous recording type may be used, also a transmitter and receiver of either the indicating or recording type, or a combination outfit, including two transmitters and one receiving indicator connected to a two-point rotary switch so that readings may be obtained with the indicator of the pressures, temperatures, etc., from either of the transmitters if desirable.

A Characteristic of a Shunt Motor—There is one peculiarity of a shunt-wound motor as commonly used which is not always recognized. When the motor is operating "cold" (before the load has been on long enough for the motor to warm up) the speed is from 4 to 5 per cent lower than after the motor is warm. This is due to the lower resistance of the fields when cold.

The Area of a Safety Valve is determined by the grate area and the pressure to be carried on the boiler. A good formula for safety valve size is:

$$A = \frac{37.5 \times G}{P}$$

where A = Area of valve in sq.in.;
G = Area of grate in sq.ft.;
P = Absolute pressure in lb. per sq.in., or gage pressure plus 15 lb.

Heating of Bearings on electric generators and motors may be due to:

Excessive belt tension in which the pulley bearing will probably be hotter than the other. To overcome this, reduce the load or belt tension.

Failure of oil rings to revolve with the shaft; oil too low; poor grade of oil; grit in the bearing or a bent shaft. The remedy is obvious.

End thrust due to improper leveling or no lateral motion of the shaft—if a belt-driven machine, move the shaft back and forth with a stick pressed against the end of the shaft. The shaft should have a lateral movement of about ⅛ in. and should float when running. If it does not, it is probably held in one position by the belt, the pulley or the collar. Sometimes the armature projects out more on one side of the field coils than on the other; in this case, the magnetic pull of the field coils will draw the armature in and the pulley or collar may bind the bearing and cause heating.

Unequal air gap—See that the air gap is equal all around the armature, for, if it is nearer one pole-piece than another, the magnetic pull will be unequal.

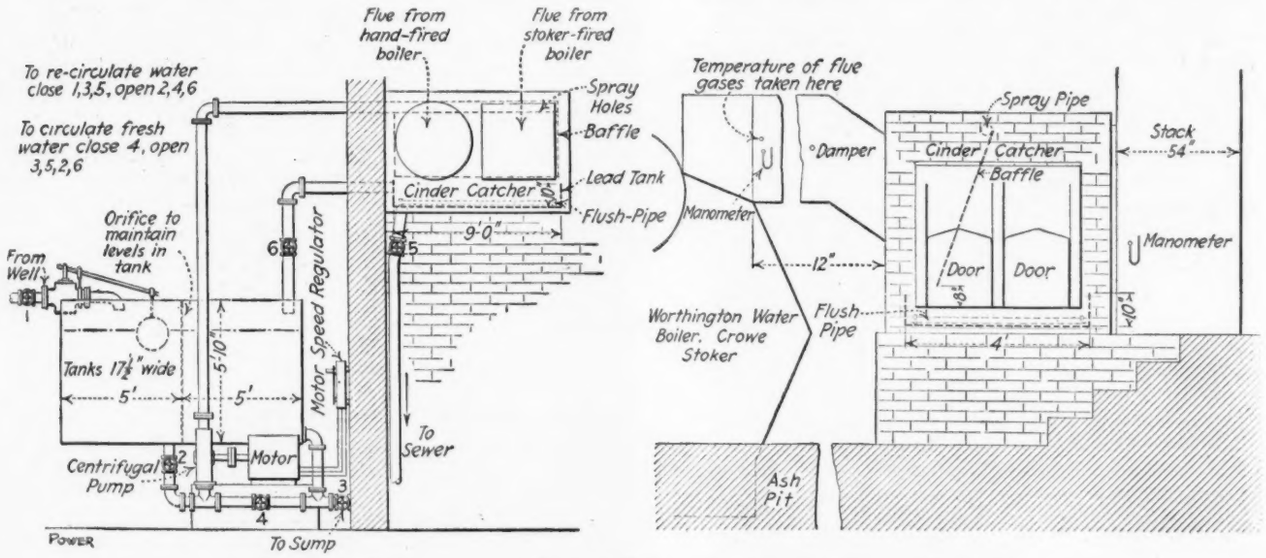
Performance of a Cinder Catcher

By M. Van Valkenburgh and M. H. Isenberg

SYNOPSIS—Describes the performance of a wet-type cinder catcher in the plant of the Hotel St. George, Brooklyn, N. Y.

The tests here described were made at the Hotel St. George, Brooklyn, N. Y., by the writers under the direction of Prof. W. D. Ennis of the Polytechnic Institute of Brooklyn, to determine the percentage ratio of cinders caught to coal burned during an average day's run of twelve hours; to determine the calorific power of the cinders and the percentage ratio of heat lost through cinders to the initial heat in the fuel; and to determine the character of the water solution after circulating through the catcher for twelve hours.

The cinder catcher is in the flue leading from a Worthington water-tube boiler rated at 295 hp. and fitted with a tank, from which it flows by gravity through a ball-float valve into one of the two twin tanks shown. It may be pumped either continuously fresh or recirculated. In either case, a motor-driven centrifugal pump of about seventy-five gallons per minute capacity forces it from the tank to the top of the baffle in the cinder-catcher, whence it flows by gravity over the plate into the tank and, if recirculating, into the second twin tank or otherwise direct into the sewer. The tank as originally installed was of sheet steel, and the baffle was constructed of a series of sheet-steel plates riveted together. After two weeks' service, the tank had disintegrated so badly, due to the acid formed by the flue gases coming in contact with the water, that it had to be replaced by a lead tank. The baffle was also attacked at the rivets, necessitating the installation of a one-piece plate.



General Elevation of Cinder-Catching Apparatus and Boiler

a Crowe chain-grate stoker. There is another unit which ordinarily discharges into this catcher, but at the time of this test it was being overhauled for repairs. The boiler has a grate surface of 82 sq.ft. and a heating surface of 2870 sq.ft., made up of 296 tubes 10 ft. long and 3 in. diameter. At the date of the test it was working under an overload, developing about 350 hp. The catcher, as will be seen from the illustration, is chiefly a sheet-steel baffle-plate with a film of water flowing over it. This plate is placed across the path of the flue gases so as to cause them to strike it and be deflected downward and through the narrow opening between it and the surface of the water in a receiving tank at the bottom. The baffle is 5x9 ft.; the receiving tank is 4x9 ft. and 10 in. deep, and the distance between the bottom of the baffle and the water is kept at about 8 in. As the gases come in contact with the water on the baffle they lose some of their cinders, but by far the greater amount is deposited with greatly increased velocity as they rush through the restricted opening at the bottom and strike the water in the tank.

The water for the catcher is pumped from a well into the cinder and the circulating tanks were flushed out clean prior to the start and the system adjusted for recirculating the water. Owing to an oversight, the flush valve was left partially open, allowing a constant small increase of fresh water into the system. However, as there were no accurate means at hand of determining the amount of water used, the relative error introduced was small.

There being no scale large enough to handle the conveyor used in hauling the coal to the furnace, it was found impossible to weigh every pound of coal put into the hoppers. During the twelve hours of the test, five conveyors of coal were weighed and their average taken. A record was kept of the number of loads used. The coal on the floor at the start was weighed and added to the total, and that at the finish was weighed and subtracted, the level in the stoker hoppers at the beginning and end of the test being kept the same. An average sample of the coal was sealed in a fruit jar for analysis.

Separate samples of the circulating water were taken at the return tank every hour during the run, and to obtain an average sample, half-pints were taken every

fifteen minutes and poured into a large vessel. The temperature of the intake and the return water was noted every hour, as were the draft and the flue temperature.

Due to the rapid evaporation at the catcher, it was necessary from time to time to replenish the circulating water with fresh water from the well. The amount of evaporation was noted each time by measuring the fall of the level in the return tank. Some of this water was lost because the lead tank in the catcher had melted over on one edge, so that when the water level rose to this point, the water flowed away into the ground. It is probable that some of the cinders were carried away at this place.

After twelve hours' continuous service the circulating pump was stopped, the fires banked, and the contents of the tanks allowed to settle. When the water had become reasonably clear, it was gradually drawn off, leaving a layer of cinder in each of the three tanks. It was found impracticable to weigh the cinder directly. Accordingly, the depth of cinder in each tank was measured in several places, the layers being of uniform thickness, and the average depth in each tank found. A fruit jar was then packed loosely full of an average sample of the cinder and sealed. Having the dimensions of the catcher and the tanks, the total volume of cinders was readily calculated, and by measuring the volume in the jar and weighing its contents, the weight was obtained. Air-drying the jar of cinders and then weighing it gave the weight of dry cinders, from which the total weight of dry cinders and the percentage ratio of cinder to coal burned were calculated. A sample of dry cinder was saved for analysis.

The coal and cinders were analyzed for moisture, volatile combustible matter and ash, and their heat value determined by the Parr calorimeter. From these and the previous results, the percentage ratio of heat lost in cinders to initial heat in coal used was calculated.

The water samples were submitted to the methyl-orange test for acid and no trace of acid found. The alkali test, however, disclosed alkali markedly present, whence it was decided that a secondary reaction had occurred between the acid formed by the combination of the SO_2 and the SO_3 in the flue-gas and the water of the catcher and the cinder in the catcher tank.

To sum up: In the twelve-hour run, 2.2 per cent. of the coal burned was caught by the cinder catcher in the form of cinder. Calorific determinations showed a heating value for the coal of 14,000 B.t.u. per lb., and for the cinder of 3100 B.t.u. per lb. The percentage of heat lost in the cinder was therefore 0.486 per cent. The system required approximately 190 gal. of water per hour. The ratio of pounds of coal burned to gallons of water used is 5.33 to 1. The reduction in draft owing to the cinder catcher was 0.309 in. water.

New Ventilating Fan and Blower

Many engine and boiler rooms where the air is contaminated with steam, dust, fumes, foul odors, etc., are benefited by putting in an artificial ventilating system. To relieve such conditions a new type of ventilating fan (Fig. 1) has been recently put on the market by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Penn. The fan differs from the older style in having more blades which are mounted on a wide central disk and which have the ends abruptly turned up. The air is thrown forward at high velocity instead of being widely spread out, and air cannot flow back through the center of the fan.

The unit is compact, and when in place the motor projects but little into the room. The motor is inclosed and protected from dust, dirt, moisture, etc. It has a high overload capacity and readily drives the fan even against a strong back pressure. Power is obtained from an electric-light circuit.

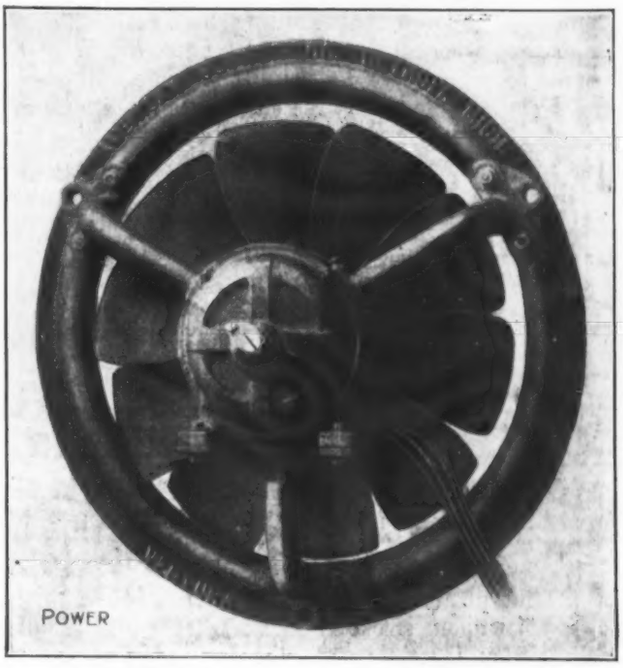


FIG. 1. NEW DESIGN OF VENTILATING FAN

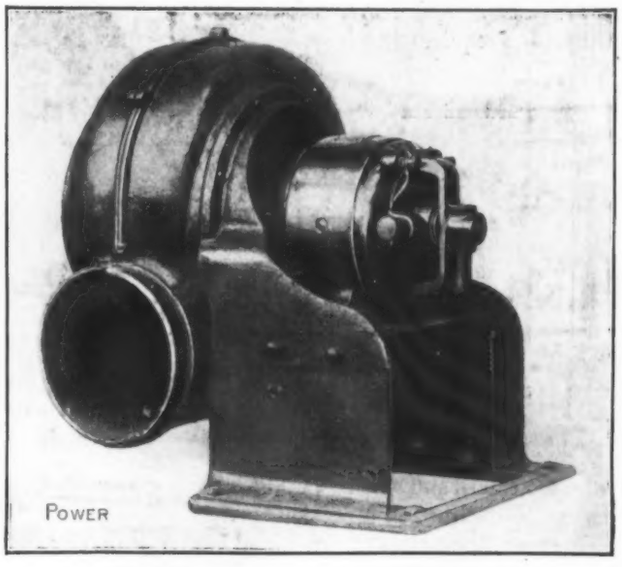


FIG. 2. MOTOR-DRIVEN BLOWER

For forcing air through pipes, a Sirocco blower (Fig. 2) is supplied. It is suitable for forcing air out of underground and inside rooms, cooling motors, and for blowing away chips, shavings, etc.

Reconstructing Existing Plants*

By Osborn Monnett†

SYNOPSIS—Problems encountered in making fire-tube boilers smokeless under conditions of low headroom, lack of space in front of the boiler, or restrictions preventing excavation.

Other discussions of boiler settings have dealt with new installations where floor space and headroom were available for proper furnace designs. If no more were necessary to smoke suppression, the cities burning bituminous coal would not be cleaned up until all of the existing settings had been burned out and replaced by new work. To obviate such a long delay it is of utmost importance that

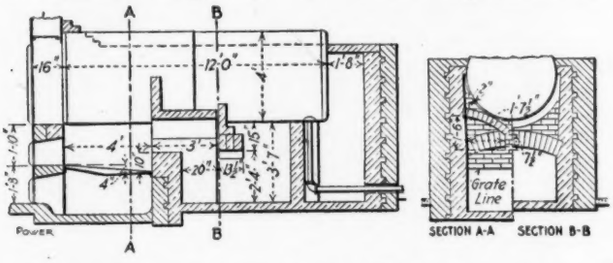


Fig. 1. Double-Arch Bridge-Wall Setting for Small Boiler; 22 In. from Dead Plate to Shell

the present plants be overhauled and put in condition to operate without smoke.

When reconstructing plants the draft must be looked to first. Patch up the setting, clean out the doors and flue caps. Stop all leaks in the breeching, take out unnecessary turns and drops, and arrange to raise the stack if the load requires it. The breeching will probably be

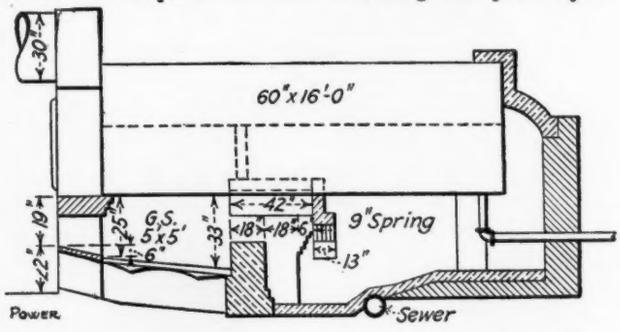


Fig. 2. Dead Plate to Shell 19 In., Lowered Dead Plate and Excavated Combustion Chamber

found too small, and when rebuilding, proper areas should be given as outlined in a previous article.

There are thousands of horizontal return-tubular boilers in use, installed years ago when low settings were the rule, which must be overhauled before any showing can be made in smoke reduction. In some fortunate cases these boilers may be raised or perhaps the foundations are in such shape that excavation may give proper headroom for the furnace installation. In other cases, the limitations of building construction make it impossible to raise the boiler, and because of floating foundations or building columns, excavation is out of the question.

*Copyright, 1914, by Osborn Monnett.
†Smoke inspector, city of Chicago.

Under these circumstances, it becomes a puzzle to know what to do with the setting to stop smoke. Fig. 1

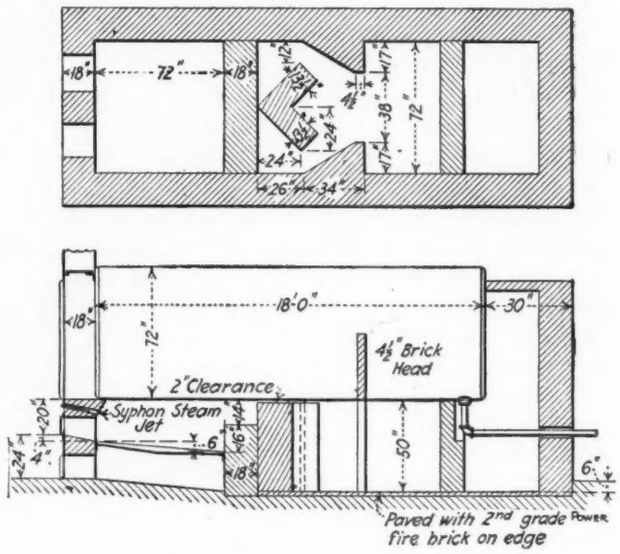


Fig. 3. No. 8 Furnace under 72-In. x 18-Ft. Boiler; 20 In. from Dead Plate to Shell

is presented to show what can be done with a small boiler set low. A double-arch bridge-wall setting is applied to a 48-in.x12-ft. boiler set 22 in. above the dead plate. Proper areas have been so worked out that good results

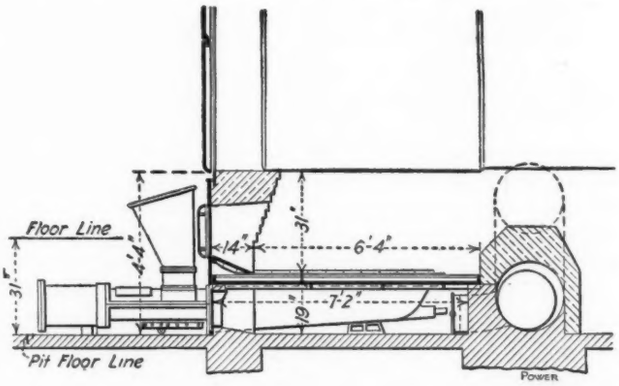


Fig. 4. Underfeed Stoker and Return-Tubular Boiler; 31 In. from Dead Plate to Shell

can be expected from the setting up to the capacity of the boiler.

Larger boilers set 18 and 20 in. from the shell to the dead plate are much more difficult to clean up, and they are many. Fig. 2 shows a 60-in.x16-ft. boiler set extremely low. The distance from the shell to the dead plate is only 19 in. To get more volume over the grates the dead plate was pitched to give a drop of 6 in. at the inner edge, as shown in the drawing. This made possible a clearance of 33 in. between the grates and the shell at the bridge-wall, giving proper areas through the furnace and a fairly good vertical bridge-wall. Another peculiarity of the setting was that a sewer passed through

the combustion chamber and in excavating only enough material could be taken out to give the required areas under the arches. From here the floor of the combustion chamber was sloped up to its original height under the blowoff. This remodeled setting is operating successfully and shows what may be accomplished by an ingenious adaptation of design in special cases. It would not be recommended for a new installation, but it can be used where other arrangements are impossible.

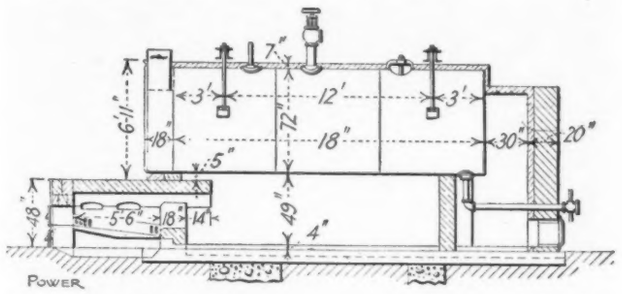


FIG. 5. BURKE GRAVITY-FEED FURNACE AND 72-IN.x 18-FT. RETURN-TUBULAR BOILER; 49 IN. FROM FLOOR TO SHELL

If floor space in front of the boiler is not available for an extension furnace, the problem may be solved by installing a Moore stoker. As has been shown previously, this stoker under tubular boilers up to 72 in.x18 ft. and 150-hp. capacity, requires only 48 in. of headroom. As shown on p. 712 of the Nov. 17 issue, the setting is made flush front and will be found of great advantage for installations requiring low headroom, especially where floor space is limited in front of the boiler.

Another condition frequently arises in connection with horizontal return-tubular boilers. Excavation is sometimes made to lower the furnace and firing floor and a pan is placed at the bottom while the floor of the combustion chamber is left at the original level of the ground. As a consequence, it is practically impossible to excavate in the combustion chamber for a deflection arch or anything approaching a double-arch bridge-wall setting.

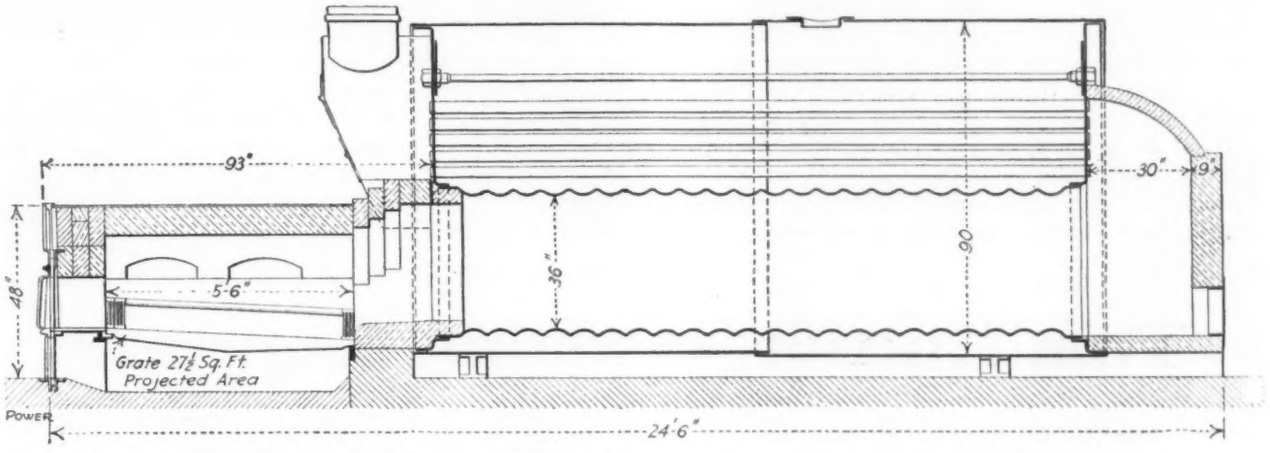


FIG. 6. CONTINENTAL BOILER, 150 HP., AND BURKE GRAVITY-FEED FURNACE

The No. 8 furnace shown on p. 166 of the Aug. 4 issue is generally much better adapted to low settings than any of the other furnaces. It is possible to work in such a setting on a 72 in.x18-ft. boiler with only 20 in. between the dead plate and the shell, though it will probably be found necessary to lower the combustion-chamber floor to get the proper areas through the setting. Fig. 3 is a typical installation with the areas worked out properly from the percentages of grate surface given in a previous article.

In connection with these old horizontal return-tubular settings, the possibilities of the underfeed stoker should be carefully considered. Fig. 4 shows a freak underfeed setting in which the dead plate is only 31 in. from the shell. This is about the lowest headroom permissible for the underfeed stoker, but the installation is running satisfactorily not only from the smoke standpoint but from maintenance. The total height of the setting from the floor line to the shell is 52 in.

Another possibility in connection with low settings for horizontal return-tubular boilers is the gravity-feed furnace. In places where the floor space is available, a Burke or McMillan furnace may be used with a tubular boiler, with a headroom of 48 in. between the floor and the shell. As shown in Fig. 5, the application is simple, and where the draft requirements are investigated at the same time and proper attention is given to operation, these furnaces will clean up an old horizontal return-tubular setting.

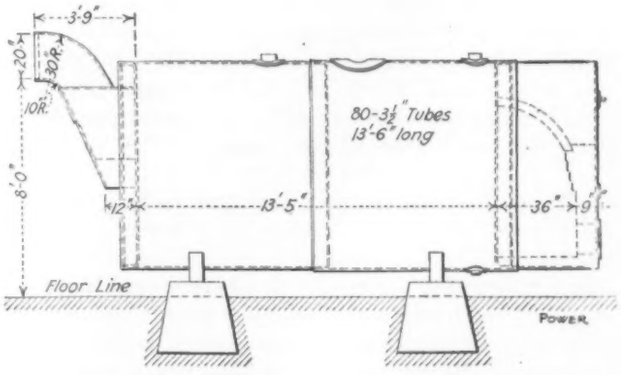


FIG. 7. CONTINENTAL BOILER WITH BREECHING INSTALLED IN HEADROOM TAKEN BY BOILER FITTINGS

Sometimes the settings are below the sewer level, so that the pan is made of metal to be water-tight; an attempt to disturb the setting will cause the firing floor to be flooded with water. This is an especially difficult installation to clean up with a hand-fired furnace.

If a No. 8 furnace cannot be worked in with the proper areas, a gravity-feed furnace may be used, provided the

pan will allow full extension. If not, then only the underfeed stoker will fit the conditions, as it is the one type of furnace which can be installed in the pan without slightly excavating the ashpit.

For low headroom the Scotch marine or Continental type of boiler is another possibility. This boiler, with a plain setting, cannot be expected to operate within any reasonable smoke ordinance, so that some type of furnace must be applied to make it satisfactory. Fig. 6 shows the standard uptake for this type; it can be employed where reasonable headroom is available. Limited headroom, however, sometimes precludes the use of an up-

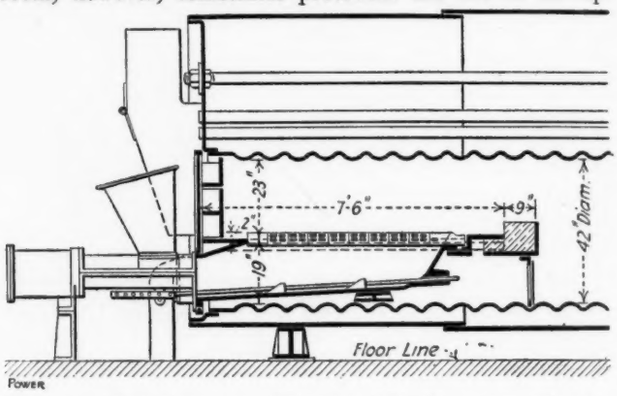


FIG. 8. CONTINENTAL BOILER, 150 HP., AND JONES UNDERFEED STOKER

take extending above the top of the boiler fittings. In this case a breeching connection (Fig. 7) can be used.

One point to be considered on this boiler is the depth of the combustion chamber. This should not be less than 30 in. in boilers up to 100-hp. capacity, and 36 in. to 150-hp. capacity.

An excellent combination is the Continental boiler and Jones stoker shown in Fig. 8. This stoker can be ap-

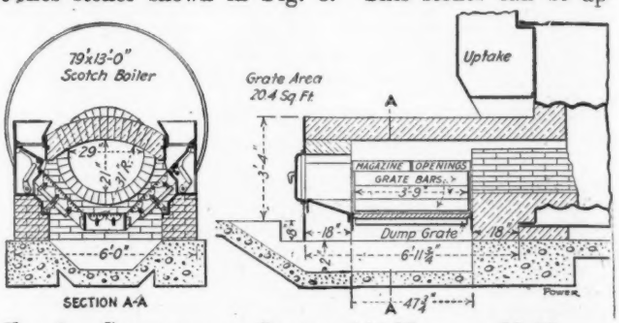


FIG. 9. CONTINENTAL BOILER, 100 HP., AND MCKENZIE FURNACE

plied to a corrugated flue as small as 36 in. in diameter and where headroom is low it offers a satisfactory solution of the smoke problem.

The gravity-feed furnace can be easily installed under a Continental boiler and makes a good semi-stoker installation where draft is available and good operating conditions prevail. It is installed in front of the boiler and needs no extended description. Fig. 6 shows a typical Burke installation on one of these units.

Fig. 9 shows a characteristic McKenzie gravity-feed furnace serving a Continental boiler and also how simple the installation becomes if there is room in front of the boiler. The gravity-feed furnaces are especially appropriate for low-pressure plants using this type of boiler, because of the absence of steam to work a stoker engine.

Tom Hunter, Hoisting Engineer

BY WARREN O. ROGERS

SYNOPSIS—Hunter discusses the question of power production for mine operation with steam and with electrical generating units. He points out that operators of large mines find it economical to build a central station to supply electrical energy for several mines. He suggests that several small operators could advantageously run a central power plant for the benefit of all, each user paying his proportionate share of the expense.

"Hunter," said I, the next day after visiting the Penn Mary power plant, "is it better for a mine operator to build his own power plant or to use central-station current for operating the mine? We have visited the mines employing both sources of electrical energy and it looks to me as if the coal operator could supply his own 'juice' cheaper than he can buy it, if he has a plant that is halfway fit. Some of them are not, I'll admit."

"Well," said Hunter, as we stepped out of the hotel at Johnstown, Penn., where we had rumpled the bed clothes during the night, "most coal-mine operators are up in the air when it comes to knowing just what saving power from either source will make. If no record has been kept of the cost of power production, the operator doesn't know if it is costing him more than what he can buy it for. He certainly has everything in his favor for so doing, because the fuel cost is low, the apparatus is simple, and the building to house it does not cost much."

"Say, some of the buildings are in a rather 'went' condition, aren't they, although several of the hoisting plants are kept up to the notch? It's the boiler houses that seem to reflect on the management more than the engine departments. However that may be, the two main things necessary to operate a power plant are coal and water, and both are had at the mine without the cost of bringing them from a distance."

"That's right, jump before you look," laughed Hunter, as we climbed onto a trolley car, bound for a mine a few miles distant. "The coal is right at the door, but its value should be figured at the price it would bring per ton if sold in the market. There is plenty of water for boiler and condenser use if—and it's a big IF—the water were good enough to use. In most instances it is not, because of acids, and then it is a case of obtaining good water from some other source. Water containing sulphuric acid will eat up boilers almost as fast as you can put them in place, which is discouraging.

"The boilers and engine units in a mine are usually of the most simple design, because the original operators did not have the foresight to put in the most efficient machinery. So, with cheap units, cheap men were hired to

operate them, although better men are now being employed; a lot of them are mighty bright fellows."

"Aren't you a little hard on the mine operators?" I asked after handing the conductor a couple of nickels. "Isn't it true that, when most of the shafts were sunk, the only accepted form of power about a mine was steam? Besides, many of the mines were in operation long before the electric motor was known. Central-station power would mean an expensive changing of everything to elec-

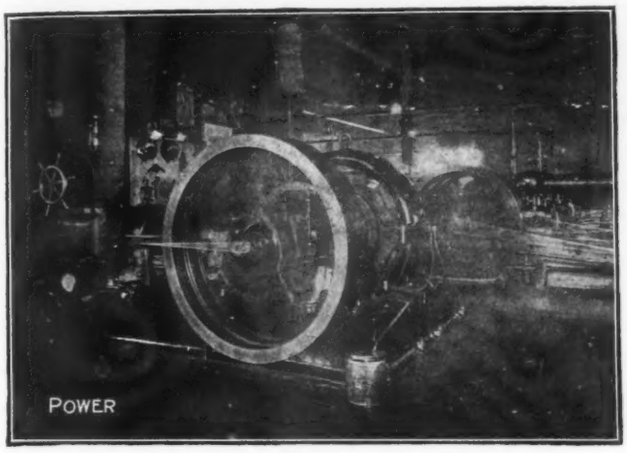


FIG. 1. A DARK, GLOOMY ENGINE ROOM

tric drive, especially in the matter of mine pumping, wouldn't it?"

"It certainly would," answered Hunter, "and the reason why some mine operators hesitate about putting in electric units is that, even with a certain rate quoted for central-station power, they are not sure what the total cost for power willl be, or whether there will be a saving or a loss.

"At some mines a twenty-four-hour service is wanted of the generating units; at others in the neighborhood, sixteen or twenty hours, as the motor-driven pumps would have to be operated during such periods to keep the mine free of water. In many mines the coal-cutting is done at night, which increases the load factor. Of course, the hoisting is confined to the day load, the few trips at night being for miscellaneous purposes. All fans will operate twenty-four hours, so that the greatest load will be during the day shift, which includes the breaker engines.

"Now, the mine operator figures that he has his steam equipment, and that if it is to be supplanted by electric drive the old apparatus must be scrapped or sold for little or nothing. Most of them cannot see that it will put any money in their pockets to displace machinery now performing their work for new apparatus that is going to cost several thousands of dollars. The plant may be dark, dirty and congested, but the wheels go 'round and that is what counts with them." (See Fig. 1.)

"Well, it is easy enough to see things from their standpoint, but I cannot see that it is always economy to balk at spending money for new machinery that will make a substantial saving in the cost of power production. I've been told—and I think it's true, judging from the scrap pile—that the foremost steel companies do not hesitate to substitute practically new machinery with something that will do the work better and cheaper, and that they find it to their advantage to do so. What works well in one place should be of value in the other. I have an idea that there are not enough data on hand on which Mr. Operator can base his figures to give an intelligent statement of what his steam plant is doing. How would you go about figuring the cost if, for instance, you were operating a mine?"

"One of the items that make up the cost of mining a ton of coal, dealing with the power end, is that of labor for operating the various engines, pumps, fans, hoists, etc. Then there is the depreciation, interest on the investment of power-plant equipment, fuel, repairs and general plant-operating expenses. Dividing the total tonnage of coal mined per day and loaded onto cars for shipment by the total cost of operating the power plant will give the cost per ton of coal produced for the market.

"This operating cost, excepting the labor and fuel, goes on whether the mine is working or not, although at a reduced rate, because fewer men are employed and not so much coal is burned in the boiler furnaces. The horsepower developed by the various engines about a mine can be determined by indicating them and striking an average horsepower output for working and nonworking days.

"The power of the fan engines, if it is not convenient to indicate them, can be calculated approximately from the size and speed of the engine, the steam pressure, the size and speed of the fan, the air pressure and volume of air in cubic feet per minute. The power required by the hoisting engine can be figured from the work being done and checked by the size and speed of the engine and the steam pressure available.

"When it comes down to facts each mine or group of mines served by the power plant presents different conditions. If one mine were supplied with power from its own steam plant and the mine closed down the overload charge against the power output would be greater than where several mines are served by the same power plant, unless all of them were closed down at the same time."

"But are there not cases where purchased power would be more economical than if it were produced at the mine?"

"I'll admit that there are; it depends largely upon the load factor, which is the ratio of the average use of the equipment required to meet the maximum load conditions. You will realize that the daily load factor is higher than the monthly ratio, because during the month the average number of working days ranges from 15 to 20. This is due to market conditions, car shortage and labor troubles. Naturally, the annual load factor is lower than the monthly, and the small plant serving such a mine would necessarily carry a high fixed charge per kilowatt-hour. This condition is lessened if current is purchased."

"There is this much to say; if a central station can supply electrical energy at a certain figure, the modern isolated plant can produce it cheaper."

"Well, they do it in other fields and it is reasonable to assume that a mining proposition can do the same." Just then the car stopped near the Berwind-White Co.'s No. 40 colliery at Scalp Level. As we made our way toward the power plant, Hunter said, "The central-station man will tell you that the individual mine plant is usually located at the least favorable point, considered from an electrical standpoint—at the mouth of the mine. He will tell you that this is so because, as the mine is developed, the electrical center of the load recedes from the plant and the loss in the distributing system constantly increases. And he is right in that also, because it will be necessary to either increase the size of the copper

transmission lines or to operate with low voltage at the point of delivery.

"He does not mention that it is a comparatively simple matter to put in an alternating-current generator and transmit electrical energy to a small substation where the energy can be transformed to direct current for use in the mine. If current were purchased it would be necessary to send it to the motors in the mine as direct current, which would mean that a motor-generator set would have to be purchased."

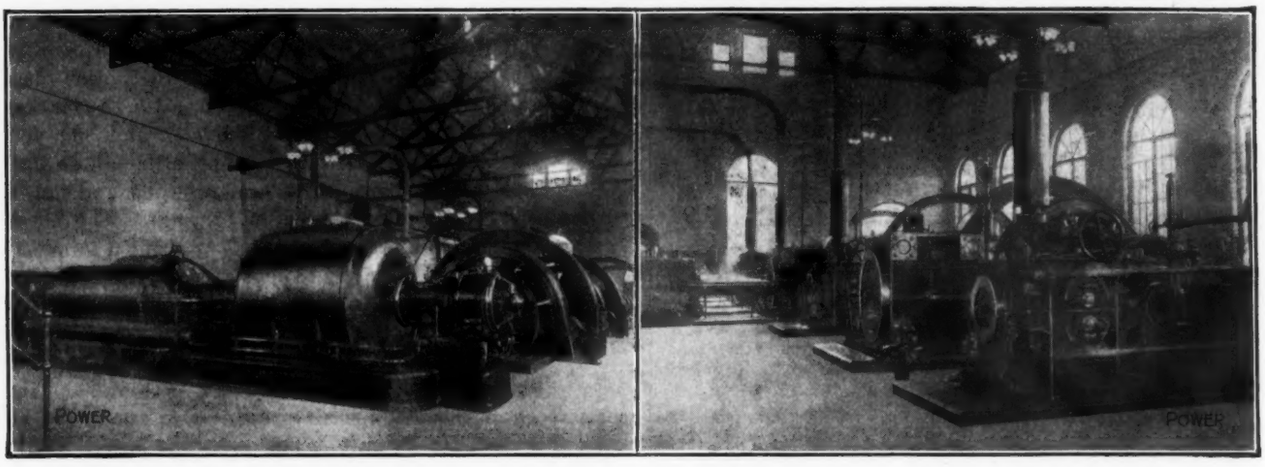


FIG. 2. TWO VIEWS OF THE POWER PLANT OPERATING THE SCALP LEVEL NO. 40 COLLIERY

We had by this time reached the power plant (Fig. 2) in which a 300-kw., 550-volt generator, driven by an 18- and 42- by 32-in. cross-compound engine was operating. This unit supplied electrical energy to motors, etc., operating in the mine close at hand. For distant transmission there was a 1000-kw. turbo unit generating three-phase, 25-cycle, 6600-volt current, which was transformed to 13,000 volts for distant transmission. Here was a situation that had been met, as Hunter had suggested, without serious line losses and low voltage at the terminal points.

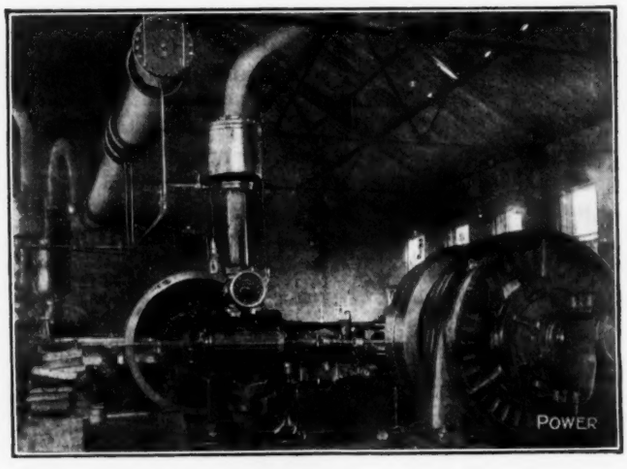


FIG. 3. PLANTS ARE OPERATED WITH BARE PIPES, LEAKING JOINTS AND GENERAL DISORDER

There were also two cross-compound 20- and 48- by 36-in. air compressors which at 75 r.p.m. delivered air to the mine at 75 lb. pressure.

"You see," said Hunter, after we had looked over the plant," that this outfit is flexible in that it takes care of short- and long-distance transmission of electrical energy, which permits of placing alternating-current motors driving direct-current generators at points where they will give the best operating results, and which can be easily moved as mining conditions change. If the mine is not gaseous, there is no reason why the substation could not be underground."

"Rather a damp place for high-tension electrical apparatus?" I suggested as we turned to leave the plant. "I should think there would be trouble with burnouts."

"Yes, that's so. I remember one case where the roof fell in on the apparatus and put the mine out of service. A brick lining was built to prevent a recurrence of similar trouble. This lining sweated so and the apparatus became so wet that there were frequent motor burnouts. This trouble was partly overcome by putting a wooden lining inside of the brickwork."

"It seems strange that several small operators do not combine and build their own central station and meter the current consumption of each operator; then each operator would pay his proportional part of the operating expense."

"Yes, I've wondered why they do not get together, but they don't. Most of them go it alone and operate their plants with bared pipes, leaking joints and general disorder (Fig. 3), even though they are less than half a mile from the next mine. It could easily be done by each operator sharing in the expense in proportion to the tons of coal mined and the amount of current consumed."

Just then the car turned a corner and we were back at the hotel in time to pay our respects to the supper table.

Thermometer and Mercury Column Reading—Whenever possible, a thermometer should be installed to give the temperature of the exhaust steam, as this temperature can be used as a check on the reading of the mercury column, but the pressure shown on the mercury column does not correspond to the exhaust steam temperature according to the regular tables of pressure and temperature relations of saturated steam. The thermometer reading will always be that corresponding to some pressure lower than the mercury column reading. This difference is due to the fact that there is always some air mixed with the steam entering the condenser and the condenser pressure is the sum of the vapor pressures of both the air and steam present. The temperature reading for the exhaust, however, will be that corresponding to the vapor pressure of the steam alone. The relation between the relative amounts of air and steam and their respective vapor pressure is one of direct proportionality of the relative volumes of the two to their separate vapor pressures.

Editorials

Interrupted Service

Electrical accidents such as that which recently paralyzed a large section of Cleveland's business district, should serve as a warning to managers who may be tempted to abandon their own plants in favor of central-station service. This is only one of a number of like instances during the past few years, and if they continue, a revision of the usual central-station solicitor's arguments would seem in order. While the occurrence is deplored and the Cleveland Illuminating Co. is to be commended for its prompt efforts to restore service, still the fact remains that business suffered heavily and several thousand were rendered idle, not to mention the inconvenience.

It would be foolish to contend that either the central station or the private plant is the more liable to interrupted service; but an accident to the former has a more farreaching effect, and the latter, with breakdown service as a safeguard, provides ample security against almost any contingency.

Striking contrast was offered between Cleveland's two largest hotels, the Statler, on central-station service, and the Hollenden, which has its own generating plant. In the former there were no elevators running and the guests were compelled to climb to their rooms and dress by candle light. Moreover, the upper floors were without water. On the other hand, everything went on as usual in the Hollenden.

A Boomerang

A member of the American Society of Mechanical Engineers, whose name is intimately associated with the word "efficiency" in magazine and other advertising matter, aspires to reform that body. Perhaps it is unfair to suggest that the motive is—publicity for himself—but a suspicion of that is strengthened by the fact that there is nothing in this instance to reform. Be that as it may, we have no quarrel with those who seek honors of the kind, but we submit that when one hopes to be carried into a position of favorable prominence on a wave of discontent he should be sure that there is water enough to float him across the flats. To begin with, it would seem most *efficient* to first investigate the existence or nonexistence of the conditions one is going to criticise.

There would have been time for a little of this even between Nov. 24, the date of an open letter to the managers of the society, printed and circulated among members, and Dec. 15, when one was addressed directly to the latter. The first was an indefinite protest against the present conduct of the society's headquarters and social affairs that amounted to a threat to "start something." It was so sagaciously worded that there was still chance to drop the matter, if the vaccination with the virus of dissatisfaction did not take on the body of the members at large.

Apparently the letter writer's own enthusiasm deceived him into thinking that he had a following, for in his second epistle he says that he had far more answers than he expected (which was modest—that he got any, surprises us; still, in any crowd, there are always some of a combative disposition, typified by the Irishman in a strange saloon who begged to know if the riot going on in the rear was a "private fight"). Further, he states that the proportion of answers from those sympathizing was over 90 per cent. We would have anticipated a full hundred per cent., for we are amazed that any but the said parties of a combative disposition would have taken the first screed seriously enough to reply to it.

Then he proceeds with his bill of particulars as to what he wants different in the running of the society, including under greater facilities for members at headquarters, rooms for transacting temporary business, writing and study facilities, stenographic and typewriting service, forwarding of mail, a dressing room, and a research bureau to consult books, pamphlets and periodicals in the library for members. If it had occurred to him to ask someone he might have learned that every one of these privileges is now among the numerous others at present enjoyed by the members who come around and take advantage of them.

Next he proposes "a small increase in annual dues to members residing within commuting distance of New York." From this we see that he has about 17 years the better of Washington Irving's hero of the Catskills, for Rip slept for 20 years, and it was only three years ago that the society considered an amendment to the constitution providing for an increase of three dollars per year to the dues of all New York members, which, when it was later put to vote, was lost.

We think we recall why he missed this, for, if we are not mistaken, it was on the occasion when this amendment was being discussed that he flounced out of the meeting in disgust after arising and asking when they were going to get to the professional papers; that he came there for the purpose of hearing and discussing them, and that the members at large were not concerned with the troubles of the New York members. Evidently he has awakened a tardy interest in the latter, howbeit it is rather inconsistent. The intent of the amendment was to care for our friend's final recommendation:

"A recognition of the social values of the society by definite entertainment once a year of outside members and their families. A simple luncheon to visitors on the days of the annual meeting and a formal reception, dance and supper."

At one time all of these were furnished free of charge to the out-of-town members, a part of the New York members paying the bills. To be exact, about 10 per cent. of the local members contributed, which obviously was unfair when, if all would do their share, $3 a man would be enough. It was to correct this injustice that the amendment was proposed, and the loss of it brought about the present "pay-as-you-go" plan whereby everyone, resident or nonresident, pays his own way to the dinner and dance and buys his own lunches. (The president's reception is financed from the society's treasury.) The

new way has approval, especially from members from outside of New York who feel that every year is too often to impose on the New York members' hospitality (the annual meetings being always in New York), while they return the compliment not oftener than once in 10 years, if at all (the semi-annual meetings being held in other cities). But all of this is ancient history to those who keep in touch with the society and know what it is doing.

This society is not perfect any more than any other, and there are some things about it which might be better, but it is only those who are too busy to get around to the meetings who have the temerity to think they can improve things. Ignorance is often the foundation of courage. It takes those who have no children to tell others how to raise theirs.

All things considered, the society is as well managed and its privileges and facilities are as complete as can be expected. The great majority of the members concur in this belief and no individual will increase his popularity by attacking the present methods without offering tangible ways of improving them. Even then he can do it more *efficiently* by adopting the usual and more courteous course of submitting his suggestions to the council. Anything else is tactless.

⁂

Yesterday and Tomorrow

How many engineers realize that over eighty per cent., say four-fifths, of the failures each year in the business world are attributed to the shortcomings of those who failed and that the remainder are due to causes apparently beyond their control?

Probably the same ratio of failures of engineers to make good will hold in the steam-engineering field. The causes may be incompetence, inexperience, neglect of duty, doubtful habits and dishonesty.

An incompetent engineer is a dangerous person in any engine room, and although employers are paying more attention to the qualifications of the men they put in charge of their power plants—because they are learning that economy in operation is essential in many instances to success—there are those who have not learned the lesson and, when a vacancy occurs, will engage almost anyone who happens along looking for a job.

When an incompetent man is in charge of a steam plant, anything is likely to occur, from a boiler explosion, or a wrecked engine, to burned boilers and bearings, scored cylinders and other power-plant mishaps which can be and are avoided by engineers who know their business.

An engineer may have had years of experience, and still be incapable of coping with the conditions existing in the plant of which he may have charge. Experience does not always make a man competent. Lack of judgment, inability to decide quickly in an emergency, and allowing matters to go from bad to worse are characteristics of an incompetent engineer.

Inexperience does not prevent a man from attempting to do work for which he is inclined, but it should prevent an engineer from occupying a position he cannot fill with intelligence and ability. It is a simple matter to operate a fifty-horsepower boiler, a slide-valve engine, an injector or a small feed pump. It is a different matter to operate a condensing plant of several units and complicated apparatus. While the inexperienced engineer might worry along in the small plant, he would be a failure in the larger one.

Negligence counteracts ability and experience and will result in an unsuccessful career. The tendency to put off doing things is characteristic of most men and retards their progress in proportion to the extent it is practiced.

The beginning of a new year is almost here, and while most of the resolutions made at that season are soon broken and cast aside, it is not a bad idea to resolve to do better, especially where known deficiencies exist. Looking back at the performance of yesterday is only useful as an object lesson of what might have been done, because most yesterdays are punctured with failures of some kind. Today there are problems which may be solved. Perhaps the mistakes of yesterday have taught nothing, or it may be that they have made a deep, lasting impression; it all depends upon the man.

But what of tomorrow? A few days ago millions of dollars were lost with the burning of the factory of Thomas A. Edison, now sixty-seven years old. According to reports, borne out by action, Mr. Edison did not stop to think of the past. Even while the fire was at its height, he was thinking of what he was going to do tomorrow. The next morning workmen were busy preparing to rebuild the works.

Do you get the idea? Yesterday and today are of the past and present, tomorrow is of the future, and is full of opportunities, except for the engineer who is satisfied to continue incompetent and neglectful.

A dishonest or grafting engineer will soon run his race and be discredited in the end. No employer will continue to employ such a man after his true character is known, and deep down in his heart the grafter knows that he is held in contempt by his fellow men.

A man's habits have much to do with his success. No engineer can carouse all night and be at his best the next day. If the truth were known, many preventable accidents have occurred while a man whose brain was clouded from the effects of the night before was on duty.

Even if criticism of a serious nature is not in order, it is worth anyone's while to look ahead with the idea of accomplishing more in his line of endeavor and not to be content unless he is steadily improving.

⁂

"It is a reflection on any city when its merchants have to build 'white ways' to light the chief thoroughfares properly, themselves shouldering the expense," says the *Electrical World*. City lighting is paid for by the citizens in their taxes; the merchants pay for their private lighting out of the profits derived from selling to the citizens, so what's the difference? The poor dear public is always the one that pays the freight in the end anyhow. If the city did all the lighting, the enterprising merchants would have no opportunity to out-illuminate their rivals. We cannot work up a great amount of sympathy for the merchants in this regard.

⁂

Take the impression received from gazing on the picture at the bottom of page 913, raise it to the *n*th power and you will begin to have a slight conception of what the present European war means to industry alone. Such destruction consequent upon accident is lamentable enough in individual cases. It is appalling when one thinks that the ruins here pictured are but typical of many more and all brought about deliberately.

Correspondence

Centrifugal Effect on Belts

On page 690, Nov. 10, W. F. Schaphorst treated certain idlers on belt drives as though they were something new, but compressor builders have long used them.

To test their efficacy, the Ingersoll-Rand Co. equipped a machine in its power house, some four years ago, and their performance was closely observed for about a year. As a result they have been adopted as standard design under the name of the "Short-Belt Electric." The compressor builder sought this means in order to solve the limited-floor-space problem, but this is not considered the only advantage, as the illustrations will show.

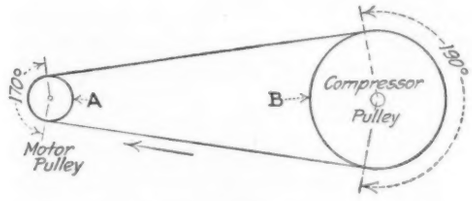


FIG. 1. LONG BELT WITHOUT IDLER

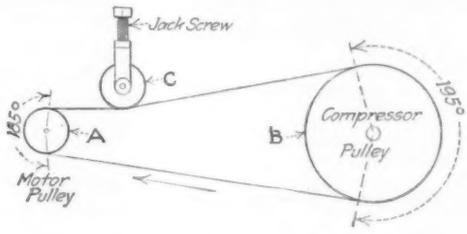


FIG. 2. FIXED IDLER

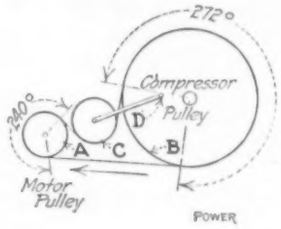


FIG. 3. SHORT BELT

Fig. 1 is the ordinary belt drive, in which the distance between centers of pulleys must be sufficient to give a reasonable arc of belt contact on the motor pulley, which at best never exceeds 170 deg.

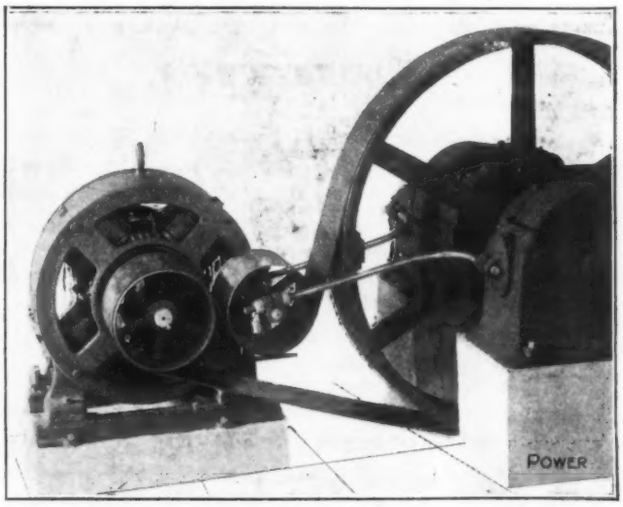


FIG. 4. SHORT BELT WITH A FLOATING IDLER

Fig. 2 is sometimes resorted to when Fig. 1 fails to work satisfactorily. A tightener pulley *C* is placed between the pulleys *A* and *B* and held firmly against the belt. This increases the arc of contact on the motor pulley to 185 or 190 deg., but it also increases the belt tension, which is undesirable.

Figs. 3 and 4 show the short belt drive. This consists of the driving pulley *A*, the driven pulley *B*, and an idler pulley *C*, which is placed on the slack side of the belt close to the driving pulley. The idler pulley is carried on arms swung from the compressor frame and is free to raise and lower, or floats on the belt.

While the idler pulley is light, its weight is sufficient to take up the slack and hold the belt against the driving pulley. When the tension on the tight side of the belt increases and lengthens the slack side of the belt, the idler pulley immediately lowers, taking up the slack and at the same time wrapping the belt further around the driving pulley and giving a greater arc of contact. The belt-contact is increased rather than the tension.

Most belt-transmission losses come from slippage or from excessive tension. With the short-belt drive there is no initial belt tension and but little slippage. When the motor is stopped the belt has no strain, and only the strain of the effort while in motion.

It will be seen from the foregoing that this form of idler has long passed the experimental stage.

CHARLES A. HIRSHBERG.

New York City.

Reciprocating-Pump Slippage

The Nov. 24 issue contains an article on "Calculating Pump Slippage," by J. C. Hawkins. His method is one advocated by many writers, but I believe it gives results that are not only misleading but which may be incorrect. Briefly, the method is to tap a one-inch pipe into the discharge line of the pump and run this small pipe to a barrel on a scales or to a tank of known capacity. Then close the main discharge valve on the pump and let the water flow through the one-inch line to the weighing apparatus, running the pump at such speed as to maintain the water pressure at the regular working pressure. The slippage can then be computed by calculating the theoretical displacement and subtracting from it the actual displacement of the amount of water pumped.

The objection to this method is based upon the following:

Experiments conducted by the writer, the results of which were summarized in POWER about two years ago, show that the slippage of a reciprocating pump is dependent upon two factors; namely, discharge pressure and piston speed. For a given pressure, curves were drawn showing the relation between piston speed and slippage. These curves reveal that at slow speeds the percentage of slip is very high, it being above 80 per

cent. in many instances. With an increase in the speed of the pump the slippage decreased rapidly until the pump reached approximately its rated speed, after which the curve became quite flat—in other words, the percentage of slippage became nearly constant.

From the foregoing it can be seen that any method of determining slippage is incorrect if it entails the running of the pump at a speed other than its regular working speed. The amount of error which might be encountered depends upon the difference between the testing and the running speeds.

If in testing, the pump is run at a relatively slow speed, the percentage of slip will be extremely high. Proof of this will be found in the fact that any pump can be run at a speed so slow that no water will be pumped at all.

One concludes that when conducting slippage tests it is important to reproduce as nearly as possible the operating conditions of pressure and piston speed, the latter being by far the more important.

MERVIN K. BAER.

Chicago, Ill.

Replacing Valves in Triplex Pumps

A short time ago I saw a tool for holding in place the springs on a pump valve where the valve chests open at the side and there is no room to hold the spring down with one hand and start the nut with the other. I always press the spring together and tie it on each side; then it can be dropped in place and the nut put on without difficulty, after which the string is cut to release the spring.

C. H. LLOYD.

Montreal, Canada.

Calculating Pump Slippage

The article on this subject by J. C. Hawkins, in the Nov. 24 issue, is misleading. The 1-in. pipe serves no useful purpose and the trouble of putting it in and weighing the water in barrels might as well be saved. Furthermore, the percentage of slippage, calculated by this method, would not be the percentage of slippage at normal or any other speed except that of the test. In fact, this method, when used on a large pump, would give a slippage of about 90 per cent. when at normal speed it was about 10 per cent.

Blank off the main discharge pipe, run the pump as stated by Mr. Hawkins so as to maintain normal pressure, count the number of strokes per minute and divide by the number of strokes per minute when the discharge valve is open. The result is the percentage of slippage with the discharge valve open. In this way the approximate percentage of slippage at any speed is readily calculated.

Mr. Hawkins also makes the mistake of saying that the slip would be greater at high than at low speeds. The opposite is apt to be the case—in fact, the slippage sometimes becomes zero or even a negative quantity at high speeds due to the inertia of the water. In other words, at high speed, the pump may actually deliver more water than its piston displacement. For this reason the only accurate method is to measure the actual amount of water delivered. A good approximation may be made by blocking the piston, removing a check valve on one end of the pump and metering the water from the drain pipe on the other with the discharge valve open and with full pressure on the pump. This will give the quantity of slippage if the drain pipe is large enough to take care of it. The piston should be blocked in several positions and the average taken.

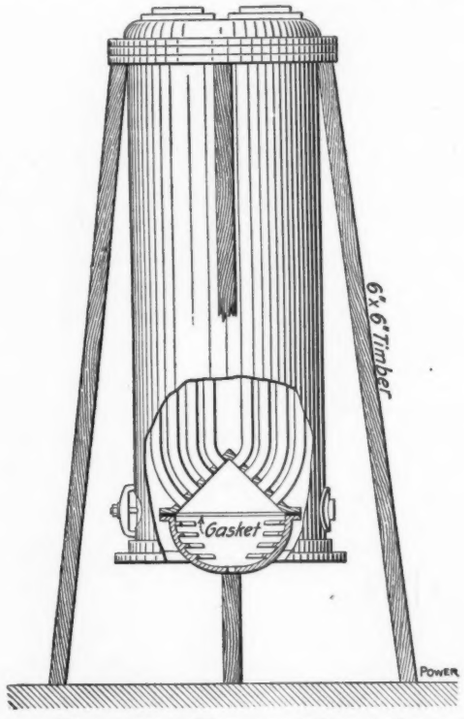
GEORGE L. SULLIVAN.

Santa Clara, Calif.

Putting Gasket in Heater

I once put a gasket in the flange of the oil separator compartment of the closed feed-water heater shown. As we were not prepared to lift the tubes out we had to do the job the following way:

First, we secured four pieces of 6x6-in. timber that were 8 in. longer than the distance from the floor to the flange at the top of the shell. With four jacks we raised



HEATER RESTING ON TIMBERS WHILE GASKET IS RENEWED

the heater 4 in. and put the 6x6-in. timber in place, nailing on braces and otherwise securing them so that they could not slip.

Then the four stands or legs were taken off, the jacks put in their places, all the bolts taken out of the bottom flange, and the bottom head lowered with the jacks and slid out of the way.

As the nuts of the separator flange could not be turned, we twisted the bolts in two, as they were all rusted through and about ready to break. We cleaned both faces and cut the gasket and stuck it to the bottom face with shellac. Soon we found that putting our work together was more difficult than the tearing down had been. As there was no room for all the bolts, we put in what we could and tightened them. Then we proceeded to find a way to finish the job.

A large manhole for cleaning purposes was near the bottom of the shell. We cut three more openings 3 in. high by 8 in. long. This gave the required room to put in all the bolts.

Next, the heater was given a cleaning and the bottom head put on, after which the shell tubes and all were lowered on the stand. Three-eighths-inch boiler steel cover-plates were made to fit over the holes we had cut in the shell, the plates being held with half-inch capscrews. These holes proved to be handy for cleaning, as we could get to all parts of the heater with a scraper and rake the scale out that lodged between the tubes.

A. G. Solomon.

Chicago, Ill.

Firebrick Mixtures and Refractories

In reading the articles by Mr. Monnett I have noted one apparent omission, the dutch-oven furnace or combustion arch over the furnace, with which I have had considerable experience.

On testing many different mixtures of firebrick and refractories in our laboratory, I have found that there are certain mixtures that will stand up better than others. Again, a flat arch that is practically level will not stand up as long as one having its height increased uniformly from the grate as it extends toward the bridge-wall. I have laid this to the fact that the hot flames and gases impinge on the flat surface and are not carried away rapidly enough.

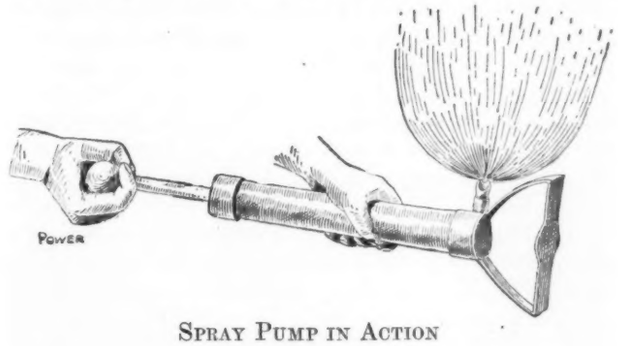
I would like to know what experience others have had along these lines and if they have made any tests of the refractories used.

A. E. Walden.

Baltimore, Md.

A Handy Spray Pump

A sprayer which can be used for many purposes about the power plant is shown in the illustration. It is made of a bicycle foot pump of the desired size and an aluminum gas-burner tip fastened with a small piece of copper wire. The wire is wound around the threaded spout of the pump on which the rubber tubing is usually attached, and the aluminum gas tip is then screwed over the wire and spout, the wire serving to keep it securely in place. The pump washer should be reinforced with several others to avoid leakage.



Spray Pump in Action

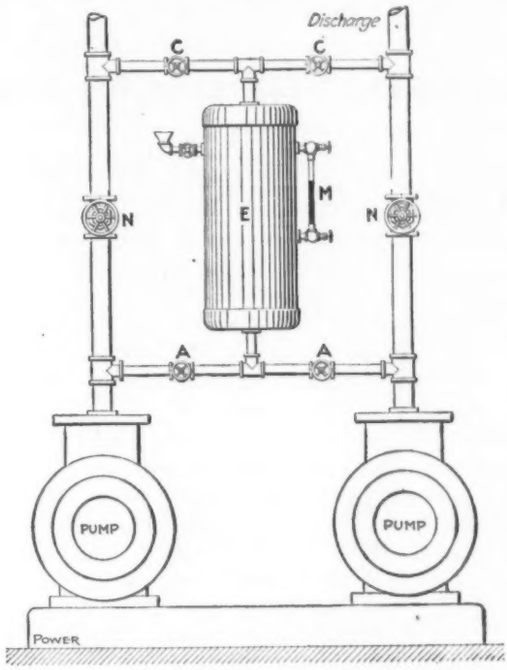
The sprayer is filled by placing it in a pail of water, disinfectant, or whatever is desired and the handle drawn back; the handle is then pushed ahead with sufficient force to suit the conditions. The spray will be a wide, fishtail-shaped thin sheet and will cover a distance of 40 ft. without difficulty. The width of the spray is approximately 3 ft. The sprayer can be put to a variety of uses, and in places that are usually inaccessible.

A. P. Connor.

Washington, D. C.

Boiler-Compound Feeder

The illustration represents a good form of boiler-compound feeder, where *E* is the body and *M* the glass gage, the merit being that the compound does not pass through the pump. The feeder can be readily regulated or cut out by valves *N*, *C* and *A* while the pumps are in operation.



Compound Feeder Connected to Two Pumps

C. R. McGahey.

Baltimore, Md.

Blanking Pump Valves

It is sometimes necessary to resort to extreme measures to keep machines in operation. Blanking pump valves or valve openings is one of them. Replacing a pump valve or valve seat may be done without much loss of time if the new parts and tools are at hand, but when the threads in the valve deck are gone it becomes more difficult. If the pump is urgently needed, the opening must be blanked off as a makeshift.

In putting a blank in the discharge deck a bolt may be fished in by a string let down through the spindle opening and tied to the end of a bolt with a heavy washer large enough to anchor firmly to the ribs on the bottom side of the deck. The bolt is then drawn up through the hole until it can be grasped by the hand from above. Another heavy flat washer is then placed upon the bolt and a nut put on and drawn up as tightly as possible and secured with a locknut. The course described cannot be followed if the bottom of the deck is inaccessible.

An anchor plate must be provided in such cases, having an oblong bolt hole in the center and be long enough to reach across and catch firmly upon the ribs on the underside of the deck, and must be narrow enough to go down through an opening in the valve seat. With a strong string looped around the bolt just below the thread and then given a half-hitch or loop at the end of the threads, the bolt is to be let down through the hole into the suction chamber, pulled up, and the upper washer put on as described.

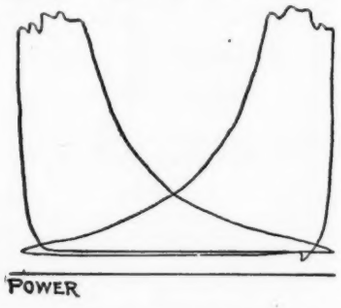
I am not advocating this as a permanent repair, but useful in an emergency.

EDWARD T. BINNS.

Philadelphia, Penn.

Ammonia Diagrams for Comment

The accompanying diagrams were taken from an ammonia compressor, with 9x18-in. cylinder, and running at



AMMONIA DIAGRAMS FOR COMMENT

60 r.p.m. The head pressure is 200 lb. and the back pressure is 20 lb.; a 150-lb. spring was used in the indicator.

I would appreciate reading the comments of readers on these diagrams.

CHARLES MUGLER.

Schulenburg, Texas.

More Discussion of Ammonia Diagrams

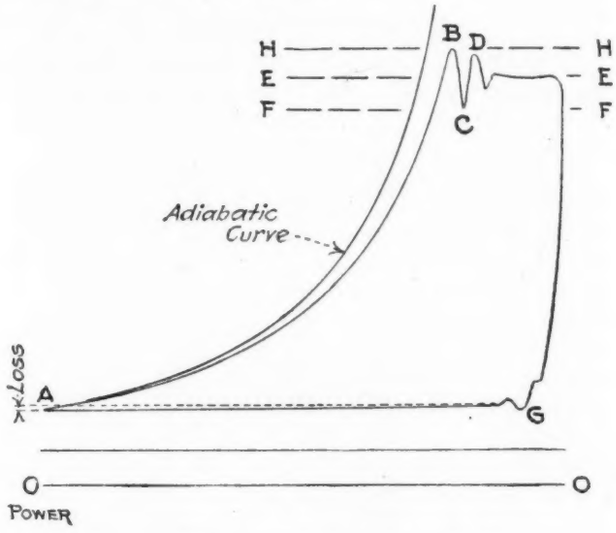
Relative to the ammonia-compressor diagram shown in the Oct. 13 issue, it does not seem to me that Mr. Losh's criticism in the Nov. 17 POWER is warranted.

Herewith is another diagram taken at the same time from this compressor, nearly a duplicate of the one under discussion. The adiabatic plotted shows nothing seriously wrong with the compression which extends from *A* to *B*. During the suction stroke *GA* and the compression stroke *AB*, the discharge valve was closed, with greater or less pressure holding it shut. It stuck to its seat and did not open until *B* was reached.

The gas in the discharge pipe meanwhile was slightly reduced in pressure by the passage of part of it into the condenser, so that when the discharge valve opened at *B*, the gas in the cylinder rushed out against a lower pressure than the average condenser pressure. The average head pressure was *EE*, not *FF*, as Mr. Losh supposes. When *C* was reached, the condenser pressure closed the discharge valve and the pressure in the cylinder was built up to *D*, the valve again sticking, but not so tightly as before, as its period of closure was not so long. At *D* the pressure in the cylinder opened the valve again and the gas passed into the discharge pipe more uniformly.

The little peaks and valleys *BCD* in the discharge line are usual with some compressors and are caused by the chattering and sticking of the discharge valves.

If the cock used to throttle the gas to the high-pressure gage is opened, the gage pointer is seen to vibrate considerably. The inertia of the gage parts "irons out" these vibrations and does not allow the pointer to show the true ranges of pressure in the discharge pipe. The indicator shows these variations more accurately. This rise and fall of the pressure in the discharge pipe indicates that the discharge valve is open until *C* is reached, even though *C* is lower than *EE*. The pressure on top of the discharge valve is not constant.



AMMONIA DIAGRAM WITH ADIABATIC CURVE

From this diagram I can find but one fault with the compressor. The pressure at the end of the suction stroke (at *A*) is less than at the beginning. This is caused by the heavy suction valve in the piston—the machine is of the vertical, single-acting type—closing itself by inertia at the end of the suction stroke, thereby causing a certain amount of wiredrawing, and reducing the capacity of the compressor. The capacity is approximately proportional to the absolute suction pressure at the end of the suction stroke. This wiredrawing is more pronounced than usual, owing to the high speed at which the machine was running. With this type of compressor, as the piston is at the top of its stroke, and reverses its direction, the suction valve tends to open itself by its inertia, allowing the gas to enter the cylinder. As the piston slows up at the bottom of its stroke, the valve tends to close by inertia, thereby cutting down the pressure in the cylinder at the end of the suction stroke and reducing the capacity of the compressor. This loss is shown at the toe of the diagram.

The whole subject of compressor indicator diagrams is interesting, but too great reliance should not be placed on them, for the quality of the suction gas, the internal heating and the discharge temperature play important parts in the performance of the compressor and are not shown on the diagrams.

G. H. CRAWFORD, JR.

Philadelphia, Penn.

Engineers' Study Course

Problems in Power-Plant Design--XI

Water Supply and Fire Protection

An important detail to be considered in the design and construction of any steam power plant is an ample and never-failing supply of water. The uses for which water must be provided in a plant of this kind may be included under boiler feeding, condenser service and fire protection. The supply for boiler feeding in noncondensing plants may be based on

$$\frac{34.5 \times 1.2}{8.3} = 4.98 \text{ gal.}$$

per boiler horsepower per hour, which allows for 20 per cent. overload. This, in round numbers, is 5 gal. per hp.-hr., and will cover all usual extras in the average plant.

The amount of cooling water required for condensing purposes will amount to approximately 30 lb. per pound of steam condensed for jet or barometric condensers, and 35 lb. for surface condensers for summer service in plants employing reciprocating engines working on an average vacuum of 26 in. In the case of turbine plants maintaining a vacuum of 28 in. this amount should be doubled.

With a condensing plant arrangements are commonly made so that the boiler feed, or at least a portion of it, is taken from the condenser, thus either eliminating or reducing this item when computing the total amount to be supplied. When a surface condenser is used, and the condensed steam is pumped back to the boilers, fresh water equal to only about 10 per cent. of that required by the boilers need be supplied. Or, when the condensing water is of good quality and allowed to go to waste, the entire boiler feed may be taken from this and no extra supply need be provided.

When determining the quantity of condensing water, Table 1 may be used as it gives the pounds of exhaust to be condensed per indicated horsepower-hour for different types and sizes of engines and turbines. The figures in this table assume that 10 per cent. of the steam supplied to the engine or turbine is condensed in doing work and by the various losses due to radiation, etc. In other words, they represent 90 per cent. of the actual water rates.

TABLE 1. WATER RATES—10 PER CENT.

Type and Size of Engine	Lb. of Exhaust per I.Hp.-Hr. to Be Condensed
Simple, high-speed	22
Compound, high-speed	18
Compound, four-valve	15
Compound corliss, over 500 hp.	13
Turbine over 500 hp.	12
Turbine over 1500 hp.	11
Turbine over 3000 hp.	10

The modern fireproof power house requires but little in the way of fire protection, but in case it forms part of an industrial plant, a system of hydrants and sprinklers usually must be provided. Unless the local rules require a different treatment, 250 gal. of water per minute at 90 lb. pressure should be supplied for each 1⅛-in. fire nozzle, and the same amount for each 60 to 70 sprinkler heads. The arrangement for the sprinklers should also be such that they will operate automatically for at least one hour.

Sources of Supply

The most frequent sources of supply are natural ponds or lakes, artificial reservoirs fed by springs or small brooks, running streams of good size, artesian wells and city or town mains. Natural ponds and lakes, provided they are of such size as not to be seriously affected by dry seasons, form a valuable source of supply, especially if they are so situated that the water may be easily raised to the level of the power house, or, better still, may flow to it by gravity from a higher elevation.

The value of artificial reservoirs fed by springs depends largely upon their stability. These should not be relied upon unless the supply for each twenty-four hours during the driest season is somewhat in excess of the plant requirements for the average working day. Supply and demand can be equalized to a considerable extent by the use of a storage reservoir of suitable size, so that water may be saved during the night when the plant is shut down. Running streams which never fall below the maximum requirements of the plant are to be classed with ponds and lakes, provided they are conveniently located and the water is of fairly good quality. In certain cases artesian wells may form a reliable source of supply. Their flow varies so greatly in different localities that general data concerning them are of little practical value. Figures at hand give for a 6-in. well sunk to a water-bearing stratum 10 ft. in thickness, with the water level lowered 1 ft. by continuous pumping, a capacity varying from 170 gal. per hr. for fine gravel without sand. In New England and similar rocky localities the flow will be much less.

Bringing the Supply to the Plant

When the plant is supplied from a pond or reservoir at a higher elevation than the power house, the water may be brought directly to the pumps by means of a gravity pipe line. If from a pond, reservoir or river at such an elevation below the power house that the lift, plus the friction head in the suction pipe, does not exceed 15 to 18 ft., a power pump of some form may be used and located in the power house. With sources like the above, but with a total lift greater than 18 ft., the same type of pump may be used, but it must be placed at such a point that the suction lift will not exceed 18 ft. With sources like the above but with an abundance of water and so located that the pump can be placed at a lower level than the source of supply, a hydraulic ram may often be used to advantage. Artesian wells require a special deep-well pump or pneumatic air lift.

Type of Pump

Direct-acting, steam-driven plunger pumps, power pumps, centrifugal and turbine pumps, driven by vari-

ous kinds of motors, are adapted to this class of work.

Direct-acting steam pumps are convenient, easily regulated and cared for, and are often employed for this purpose when the conditions are such that they can be located in the power house and their exhaust utilized for heating purposes.

The principal objection to this type of pump is its large steam consumption, which may be taken approximately as follows:

Simple noncondensing	120 lb. per hp. per hour
Compound noncondensing	80 lb. per hp. per hour
Triple noncondensing	40 lb. per hp. per hour

Power pumps of the plunger type are also adapted to this class of work under certain conditions and may be driven either by steam or gas engines, electric motors or may be belted to a countershaft. Pumps of this type may be located at a distance from the power house and operated by an electric motor; this gives them an advantage over the direct steam pump under certain conditions. The chief disadvantage of this pump, under some conditions, is that it must run at a constant speed, but this is not an objection when it is used for pumping from a lake or a river into a reservoir. In case of boiler feeding and similar work, where close regulation is required, it is a disadvantage which must be considered. The centrifugal or turbine pump is especially adapted to the handling of large volumes of water under moderate heads, and is also constructed for high-pressure work when required.

This pump is simple in construction, requires practically no care and may be direct-connected to an electric motor or steam turbine, thus making a compact and effective unit. It has the same limitation as to speed as noted in connection with the plunger pump.

Capacity

The catalog ratings of pumps usually give the theoretical capacity, hence in estimating the actual capacity the slip or leakage around the piston and valves must be taken into account by multiplying by a factor depending upon the type and the size of the pump. Table 2 gives factors for this purpose.

TABLE 2. ALLOWING FOR PUMP SLIPPAGE

Type of Pump	Actual as Compared with Theoretical Capacities
Medium piston and plunger	0.85
Small piston and plunger	0.75
Large centrifugal	0.80
Medium centrifugal	0.55
Small centrifugal	0.35

Power for Driving Pumps

The actual horsepower required for driving a pump is given by the formula

$$hp. = \frac{W \times H}{33{,}000 \times E}$$

in which

$hp.$ = Horsepower required;
W = Pounds of water raised per minute;
H = Height of lift, in feed, including the friction head in both suction and delivery pipes;
E = Efficiency of the pump,

which may be taken as follows: Triplex power pumps, 60 to 80 per cent. for total heads of 100 to 300 ft. respectively. Centrifugal pumps of the best class, 50 to 70 per cent., depending upon size and conditions under which they operate.

The Clinkering of Coal*

By LIONEL S. MARKS

There is a growing feeling among large coal users that the important matter of clinkering ought to be taken care of in some way when making contracts for coal. It is frequently suggested that specifications ought to include the melting temperature of the ash as this has generally been assumed to determine the amount of clinker formed.

Before the subject of clinkering can be put upon a satisfactory basis, two kinds of measurement are necessary: (a) the determination of the extent to which the clinkering of a given coal is objectionable, and (b) the determination by a laboratory test of some characteristic of the ash which indicates the objectionableness of the clinker.

The important fact about clinkering is not so much the total weight or volume of clinker formed as the kind of clinker—i.e., whether nonadherent, easily broken up and easily removed, or whether it forms a pasty mass with the surrounding coal, or which runs on to the grate and freezes there as a strongly adherent but thin sheet.

It is probable that the only reliable basis at present for determining the "objectionableness" of the clinker is the judgment of fireroom observers. The writer has attempted to get a quantitative measurement by sifting the ashpit refuse into a number of selected sizes. In tests made with a Murphy stoker equipped with the usual clinker-breaker, the coals which gave most trouble were found to have the lowest percentage of smallest size clinker (less than 1 in.) and the highest percentage of the largest size clinker (greater than 2 in.) The differences between the percentages of the different sizes for good and poor coals is small, so that the method cannot be relied on.

The only kind of laboratory test on coal ash which would seem to be of value in indicating the probable extent and character of the clinker is one in which the ash is subjected to such temperatures as will cause it to melt. A number of attempts have been made to determine the melting temperature of an ash from its chemical analysis, but none has been satisfactory.

That valuable indications may be obtained from a knowledge of the iron and sulphur content of the coal or of its ash, is suggested by some recent tests of Palmenburg,† which, as pointed out by Bergwyn,‡ appear to show the following results:

An ash containing less than 10 per cent. of iron oxide (Fe_2O_3) does not fuse at a temperature below 2550 deg. F.; an ash containing more than 20 per cent. does not fuse at a temperature above 2550 deg. F.; for an ash containing between 10 and 20 per cent. the fusing temperature varies widely.

A coal containing less than 1 per cent. of sulphur does not fuse at a temperature below 2550 deg. F.; a coal containing more than 2 per cent. does not fuse at a temperature above 2550 deg. F.; for a coal containing between 1 and 2 per cent. the fusing temperature varies widely.

A coal containing less than 3 per cent. of iron oxide plus sulphur does not fuse below 2550 deg. F., and a coal containing more than 3 per cent. does not fuse above 2550 deg. F.

The determination of melting temperatures of coal ash is attended with many difficulties, the more important of which is in the definition of the melting temperature. When a coal ash is heated slowly, that one of its constituents which is the most fusible will be the first to melt. Its effect upon the rest of the ash will depend upon three factors: (a) the amount of that constituent; (b) its viscosity when melted; and (c) its chemical reaction on the remaining constituents. If there is much of this constituent the ash will become fluid to an extent which depends upon its viscosity. If the molten part is small in amount but very fluid, it may separate from the rest.

There is another factor of importance in connection with the behavior of molten coal ash, namely, its viscosity. A satisfactory laboratory test for clinkering should indicate viscosity as well as melting temperature. The only method used to any extent for this purpose is really an imperfect one of determining the temperature at which the material has a standard viscosity. This is accomplished by heating the material in the form of a Seger cone of standard dimensions, at a standard rate, until it has bent to some standardized final form. The cone has usually been set up vertically. The rate of rise of temperature is usually taken as 2 deg. C. (or 4 deg. F.) per minute and the melting temperature taken as that at which the tip of the cone touches the base. This method, it

*From a paper read at the annual meeting, December, 1914, of the American Society of Mechanical Engineers.

†"Journal of Industrial and Engineering Chemistry," April, 1914.

‡"Journal of Industrial and Engineering Chemistry," August, 1914.

will be observed, does not give a standard viscosity unless the time from the beginning of bending is the same in all cases. It should be noted also that the temperature of the cone increases as the bending goes on.

In tests by the writer with a standard rate of heating of 2 deg. C. per minute, the time taken for the cone to bend to its final position from the beginning of bending, has varied from 10 to 80 minutes; the final viscosities in these two cases are obviously different. It should be noted that even if this method gave standard viscosities, it would not necessarily give information of value on clinkering. If it were true that all clinkers became troublesome when they reached a certain lower limit of viscosity, and if that particular viscosity were chosen as the standard, one might expect a close relation between laboratory and fireroom results. It has not, however, been shown that there is a lower limit of viscosity of the ash which cannot be exceeded without trouble from clinker, and moreover, in ashes whose most fusible constituents are very fluid the Seger cone method fails as indicated below.

Notwithstanding these inherent defects, the Seger method appears to merit further investigation, but an important modification in its use seems to be advisable. In the standard method the cones are placed vertically. This gives satisfactory results with the original Seger cones and with many fire clays, but it is often unsatisfactory with more complex mixtures. If the more fusible constituents are very fluid they run down to the base of the cone and may leave the apex apparently unchanged in a vertical or slightly inclined position until it disappears; that is, the cone never assumes the standard final shape. J. P. Sparrow, of the New York Edison Co., has suggested placing the cones horizontally with the apex projecting over the side of the support. This method has been adopted by the writer as being more sensitive than the usual method and as giving indications which can be duplicated more accurately and are, therefore, more reliable. The temperatures noted in this method of testing are at the beginning of bending and when the apex of the cone points vertically downward.

Tests of melting temperature observations on samples of coal ash by two or more laboratories bring out the fact that widely different results are obtained with the same ash samples.

The more important factors influencing the melting point of the ash are: Nature of the surrounding atmosphere; size of the cone; position of the cone; nature of the binder; rate of heating; location of the cone in the furnace; and method of support of the cone.

Table 1 gives the melting temperatures observed in the two furnaces. The cones were in all cases vertical. The dates are those on which the coal (from which the ash sample was obtained) was burned under a boiler. It will be seen that the temperature difference ranged from 120 to 255 deg. C. (260 deg. to 459 deg. F.). It should be noted also that even the order of fusibility was changed in some cases when the atmosphere changed, and that the lower the fusing temperature in an oxidizing atmosphere the greater is the increase in fusing temperature when changing to a reducing atmosphere. The atmosphere in a boiler furnace is always oxidizing. Therefore, it is important that the cone should be surrounded by an oxidizing atmosphere.

TABLE 1. INFLUENCE OF ATMOSPHERE ON THE MELTING TEMPERATURE OF ASH CONES

Date	Melting Temperature Deg. Cent. Reducing Atmosphere	Oxidizing Atmosphere	Difference Deg. Cent.
Feb. 3	1560	1430	130
4	1580	1410	170
5	1580	1410	170
6	1605	1390	215
10	1620	1380	240
13	1635	1440	195
Mar. 3	1595	1440	155
5	1620	1365	255
11	1580	1400	180
13	1610	1445	165
17	1620	1500	120

The size of cone has an influence which is different for different materials. With Seger cones the difference is negligible. For example, a No. 16 Seger cone (17 mm. base, 70 mm. high) placed horizontally, has a melting temperature (initial and final bending) of 1355 to 1410 deg. C.; when molded into the standard size of Seger cones of higher fusing temperature (8 mm. base, 30 mm. high), the result is 1355 to 1420 deg. C. The size of the cone adopted in the writer's tests was 11 mm. base and 52 mm. high. One ash sample tested horizontally in a cone of this size gave melting temperature from 1425 to 1450 deg. C.; in a 13-mm. base, 57 mm. high cone, the temperature was from 1400 to 1430 deg. C. As is to be expected, the larger cones show a lower melting temperature, but the difference is not great.

The melting temperature (complete bending) of a horizontal cone is always less than for a vertical cone. The difference varies considerably and is less with the more fluid melts.

The ash is usually mixed with a 10 per cent. solution of dextrin before molding into cones. It was found, however, that water alone was satisfactory if the cones are not dried much before being put in the furnace. The effect of adding dextrin is generally negligible, but sometimes it increases the apparent fusing temperature (complete bending) by as much as 10 deg. C.

The rate of heating the cones has a marked effect on the apparent fusing temperature. Any increase in the rate results in increased lag of the pyrometer (Le Chatelier type with porcelain tube) and causes an apparent decrease in the melting temperature. Tests on the ash showed melting temperatures (complete bending) which were 40 deg. and 35 deg. C., respectively lower, with 6 deg. C. increase per minute, than with a 2-deg. C. increase per minute.

The location of the cone in the furnace is important; it should be as close to the pyrometric element as possible. The temperature at the front of a No. 29 Meker furnace was found to be about 20 deg. C. lower than that in the middle of the muffle. An additional door plate reduced this difference.

The cone must be supported on material unaffected by the highest temperature reached, and which does not react chemically on the ash cones. Plates of fused quartz have proved satisfactory. They have to be supported so as to permit circulation of the gases below them, to give them the same temperature as the rest of the muffle.

Another point of importance is the complete incineration of the ash before it is made into a cone. An appreciable amount of carbon remaining unburned tends to increase the apparent fusing temperature.

The writer used a Meker furnace in all of the later tests made in his laboratory. Holes were made in the back of the furnace for the insertion of the pyrometer, and in front for observation and for the insertion of a quartz tube through which a stream of air was introduced into the muffle to insure an oxidizing atmosphere. The furnace was heated rapidly to within about 200 deg. C. of the expected fusing temperature and the rate was then reduced to 3 deg. C. per min. and kept there. The observation hole was plugged except when in use. Observations were made through dark blue glass at 2½-min. intervals. The horizontal cones were supported only so far as was necessary for balance.

To find out whether fusing temperatures as determined by the method outlined have any relation to the amount of clinker trouble experienced in burning the coal, a series of tests was carried out on a boiler equipped with a Murphy stoker at the L St. plant of the Edison Electric Illuminating Co., of Boston. Fourteen tests were made, each of 24 hours' duration, with 10 different coals; five of the tests were made with one coal, and one test with each of the nine remaining coals. The conditions of all these tests were kept the same so far as possible. Each test started at 7 a.m., and a load of from 150 to 175 per cent. of the rated load was maintained until 5 p.m., when forced draft was put on and the capacity kept at 200 to 250 per cent. of rated load for 2 hours. The capacity was then reduced to from 150 to 175 per cent. till 11 p.m., when the fire was banked until 7 a.m.

Table 5 gives the results of tests of the ash and a statement of the extent of the clinkering for each of these tests.

It will be seen that there is a general relation between the two, but that it is not definite enough to be of much practical use. The coals giving the three lowest fusing temperatures are also those giving the maximum clinker trouble. Those ashes with a final fusing temperature of 1400 deg. C. (2552 deg. F.) or higher, gave little trouble, as did the ash, which melted at 1380 deg. C. (2516 deg. F.), while others which melted at 1395 deg. C. (2543 deg. F.) gave much trouble. The most troublesome clinkers had final melting temperatures of 1370 to 1375 deg. C. (2498 to 2507 deg. F.), which is practically the same as the temperature for coal that gave good results. It would appear then that the final melting temperature cannot be taken as a criterion in the range from 1380 to 1400 deg. C. (2516 to 2552 deg. F.), and the inference is that the uncertain region extends over a still wider temperature range. It is probably true that final fusing temperatures below 1350 deg. C. (2462 deg. F.) show a coal which would give clinker trouble under the conditions of the L St. station, and that temperatures above 1420 deg. C (2588 deg. F.) indicate a coal comparatively free from such trouble, but further investigation would be necessary to establish that fact. The important thing, however, from the point of view of coal specifications, is that the tests of the ash of Feb. 3, 4, 5 and 6; Table 2, when the regular station coal was used which gave a minimum of clinker trouble, yield results which fall in the doubtful region and would, therefore, be rejected in coal specifications based on fusing temperatures alone. Tests made at the New York Edison Co.'s laboratory on ash having a mean fusing temperature of 1245 deg. C. (2272 deg.

F.), would, from the experience of the New York Edison Co. Mr. Sparrow reports, "indicate serious trouble from clinker in commercial service. This remark applies to combustion on a Taylor stoker. Tests in Boston gave the same melting temperature for two coals, although one was found to give negligible and the latter excessive clinkering in actual use.

TABLE 2. MELTING TEMPERATURE OF ASH AND FIRE-ROOM RECORD OF CLINKERING

Date	Melting Temperatures, Deg. Cent. (Fahr.) Initial and Final Bending	Range	Amount and Character of Clinker
Feb. 3	1350-1395 (2462-2543)	45 (81)	Light
4	1360-1400 (2480-2552)	40 (72)	Light
5	1360-1400 (2480-2552)	40 (72)	Light
6	1340-1380 (2444-2516)	40 (72)	Light
10	1360-1375 (2480-2507)	15 (27)	Hard, excessive; 50 per cent. of grate
13	1350-1395 (2462-2543)	45 (81)	Excessive to moderate; large clinker
Mar. 3	1370-1420 (2498-2588)	50 (90)	Not much but very hard and isolated
5	1350-1370 (2462-2498)	20 (36)	Excessive; 75 per cent. of grate
11	1355-1380 (2471-2516)	25 (45)	Heavy
13	1340-1395 (2444-2543)	55 (99)	Heavy
17	1430-1480 (2606-2669)	50 (90)	Light
24	1420-1450 (2588-2642)	30 (54)	Very little
26	>1500 (>2732)		Light, hard
Apr. 8	1335-1370 (2435-2498)	35 (63)	Excessive, very hard, 18 to 20 in. in V and thick

Additional indications of the liability to clinker trouble may be obtained from the range of temperature during bending and from the appearance of the bent cone. The cones of the ash which gave most trouble had a very fluid constituent which ran down to the tip of the cone and also upon the supporting plate. It would appear that the most fusible constituents will separate from the rest of the cone, leaving a skeleton which does not bend until its own fusing temperature is reached—that is, with the kind of ash which gives most trouble, the Seger cone method fails as a result of the separation of the more fusible from the less fusible constituents.

It is possible to accept the appearance of the bent cone as a partial indication of the clinkering behavior, and it may be possible to predict the behavior of an ash from that indication combined with the fusing temperature. The range of temperature during bending may also possibly be used. There seems to be a close relation between this range and the viscosity of the melted cone. It should be noted, however, that there is a liability to error in observing the initial and final bending temperatures, when the range is not less than 10 deg. C., so that an observed range of 30 deg. C. may actually be anywhere from 10 deg. to 50 deg. C. It is necessary to make several determinations to get the range with reasonable certainty. The appearance of the melted cone is consequently more valuable than the range of fusing temperature.

The investigations of the writer seem to show that under the conditions of combustion at the L St. plant of the Edison Electric Illuminating Co., of Boston, a coal with a fusing temperature (final bending) below about 1400 deg. C. (2550 deg. F.) will probably give trouble if the ash has a fluid constituent, whereas it will not give trouble above about 1380 deg. C. (2516 deg. F.) if the ash is viscous. This conclusion would require further investigation with many other coals before it could be accepted even for this particular plant; naturally it cannot be applied to plants with different operating conditions.

It may be interesting to note here the conclusions reached by other investigators as to permissible fusing temperatures. Mr. Sparrow, in a report to the Association of Edison Illuminating Companies, September, 1914, states as a result of boiler tests with a Taylor stoker, using 13 different coals:

> It will be seen that the critical point of ash fusion lies between 2400 and 2500 deg. F. All coals where ash fusion temperatures are above 2500 deg. F. can be classed as non-clinkering (those below 2400 deg. F. as clinkering; using 2450 deg., therefore, as a standard, there is an allowable margin of 50 deg. F. above and below standard to cover possible errors in testing.

Most of his boiler tests lasted 120 hours. The ash fusion tests were conducted under conditions similar to those used by the writer. The fusing temperature is the middle of the range from initial to final bending of the cones. It should be pointed out that the fusing temperatures obtained in Mr. Sparrow's laboratory average about 260 deg. F. less than those obtained for the same ash in the writer's laboratory.

E. J. Constan, as a result of his investigations, finds that the melting point of coal ash varies from 1150 deg. C. (2202 deg. F.) to 1700 deg. C. (3092 deg. F.) and recommends the following ash-melting temperatures: For boiler coals, above 1400 deg. C. (2552 deg. F.); for locomotive and producer plants, above 1500 deg. C. (2732 deg. F.).

Centrifugal Pumps for Boiler-Feed Service*

Eight or ten years ago the use of centrifugal pumps for boiler-feed service was practically unthought of. In recent years, however, there has been considerable experimenting with pumps for small capacities and high heads, such as are encountered in boiler-feed work, and now the reciprocating boiler feeders have practically been eliminated from the more modern plants, where the capacities run over 1750 boiler horsepower.

One of the first centrifugal pumps of real commercial merit, if it was not the first, was that placed in a large paper mill. This plant had a boiler capacity of 12,000 boiler horsepower and the pressure was 140 lb. The boilers had been supplied by two compound duplex pumps of the outside end-packed type. The steam ends of these pumps were in bad shape, and by a weighed water test it was found that they were taking about 120 lb. of steam per water horsepower per hour. They had no use for this exhaust steam.

A short time before the company considered using a centrifugal boiler feed pump, it had put in a cross-compound condensing Corliss engine with generator, on which an economy of about twelve pounds of steam per indicated-horsepower per hour was obtained. Inasmuch as there was an excess of electrical power, it was decided to put in a motor-driven four-stage centrifugal pump designed for a capacity of 1080 gal. per minute against a total head of 380 ft., or 165 lb. A great deal of attention was given to the difference between the steam and the water pressures and this was figured low in order to make the units as economical as possible.

With an economy of 12 lb. of steam per indicated horsepower per hour, and with allowance for the engine efficiency and that of the motor and the pump, the centrifugal pump took about twenty-five pounds of steam per water horsepower per hour. This was a saving of about ninety-five pounds of steam per water horsepower per hour, or with the pump operating at its full capacity, a total saving of 9850 lb. of steam per hour.

Inasmuch as this pump did not operate continuously with full capacity (this was figured with a margin of safety of 50 per cent. over the normal rating of the boilers), it was assumed that a safe figure for the economy of the centrifugal pump would be not more than thirty-five pounds of steam per water horsepower per hour, or a total saving of about 8800 lb. of steam per hour, or 293 boiler horsepower on a 30-lb. rating.

At this plant there is a saving of approximately $10,000 per year on coal alone. Besides this saving, after the pump was installed it was found that there was also a saving on the fittings and valves as there was a complicated distribution system. The absence of the shocks almost eliminated the repair bill on this item.

The pump was installed with a head on the suction side of about six feet, the water handled being about 210 deg. F. No back pressure is carried in the heater. This pump has now been operating for eight years, and the only repairs were one thrust bearing and a set of wearing rings, or a total charge of about $100. The cost of the equipment was between $3800 and $4000.

The conditions in this case were somewhat peculiar in that there was a sufficient supply of exhaust steam for heating the feed water without the use of exhaust steam from the boiler feeders. In the ordinary plant, especially in a central station, the main units run condensing and the auxiliaries run noncondensing, using the exhaust steam for heating the boiler feed water.

A further advantage of the steam-driven auxiliary idea is that the boiler supply is not dependent on the continuity of current. In a station having but one or two electrical units, it is rather dangerous to make the auxiliaries motor-driven on account of the possibilities of a short circuit shutting down the motor and interrupting the water supply to the boilers. As the turbine uses no cylinder oil the heater gets clean steam and the boilers are not subject to oil trouble.

There is practically no limit to the size of a turbine-driven boiler feed pump, which can be built either in the lower or the upper scale. In other words, boiler feed pumps operate at a capacity as low as 10 gal. of water per min. against 250 lb. pressure and as high as 1600 gal. of water per min. against 280 lb. pressure.

The following rules are desirable to follow in connection with figuring on boiler feed pumps:

The normal rated capacity of the boilers is ordinarily taken and 50 per cent. added to that for the capacity of the pump. In other words, a 10,000 boiler horsepower having a

*Excerpts from a paper by Edward S. Adams before the Ohio Society of Mechanical, Electrical and Steam Engineers, Columbus, Ohio, Nov. 19, 20 and 21.

normal feed of about 600 gal. of water per minute would be supplied with a pump having a capacity of 900 gal. per minute.

The water pressure is ordinarily figured with a differential of from 25 to 30 lb. where the conditions cannot be closely approximated. This differential has been made as high as 60 lb., which is a departure from the general rule mainly on account of the prejudice of an operating engineer or water tender.

Where a turbine pump feeds more than one battery of boilers, and where it may obtain its steam supply from one battery and supply water to another, it is always specified that if the normal steam pressure should be 150 lb., the turbine shall carry its full load on as low as, say, 100 lb. pressure, and in some cases as low as 70 lb. This feature can be obtained by supplying auxiliary shutoff valves and nozzles, which are used only in cases of low steam pressures.

It is a good idea to get as much head as possible on the suction side of a centrifugal pump handling hot water. Ten feet is considered a good average, although there are some pumps operating with a head on the suction side as low as three feet. However, in these cases the conditions are rather constant, the load does not fluctuate much, and there is practically no possibility of entrained air being carried into the pump.

The mistake of buying the cheapest turbine-driven centrifugal pump offered is frequently made. While it will perform its work for a short time in the ordinary way, it soon deteriorates, as there really is not much more severe service on which centrifugal pumps can be used than that for boiler-feed purposes. The turbine also usually receives rough treatment, as in nine cases out of ten it is under the care of the water tender.

There are a few fundamental features in connection with centrifugal pumps in general, and centrifugal boiler-feed pumps in particular, which determine whether an installation is going to be satisfactory.

On account of the high pressures encountered it is important to provide removable bronze wearing rings on both the impeller and casing at the joint between the suction and discharge chambers. There should also be bronze sleeves over the shaft and removable stationary sleeves in the casing between the impellers. The impellers should be made of bronze in all cases.

On account of the possibility of the boiler pressure decreasing, which will decrease the pressure against which the pump is to operate, and because of the further fact that at this time there is ordinarily a great demand for feed-water to the boiler, as the steam pressure has likely been caused to drop by overload on the boilers, the pump should be so designed that, regardless of the head against which it is to operate, the horsepower taken by it will not exceed a certain predetermined amount. While this is especially true with motor-driven pumps, it also applies to turbine-driven pumps as a serious overload (due to the enormously increased capacities which are obtained on some designs of pumps when the pressure is dropped) sometimes destroys the turbine.

The points which make the centrifugal pump superior to the reciprocating are better steam economy, simplicity and ease of operation. It requires no expert to keep it up to the standard. There are no steam valves to be set, no indicator diagrams to be taken, and no valves or seats to replace. The impossibility of building up an excessive pressure insures no undue strains on the piping. In a properly designed centrifugal pump it is impossible to build up a pressure in excess of a predetermined head, known as the shutoff pressure, and beyond which the pressure will not go.

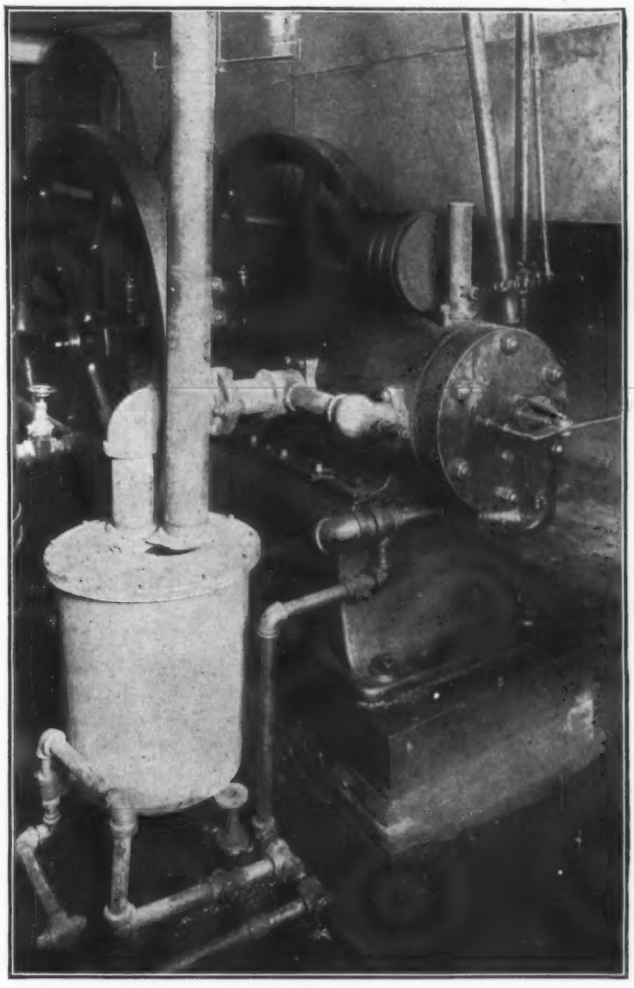
One of the more important points, however, is the absence of shock or pulsation. The pressure is built up gradually and when the boiler-feed regulator opens there is no hammer in the line, the pressure is always ready to force the water into the boilers without a pump governor and speeding up the pump. In case the water should become too hot or should not flow, there is no danger that the centrifugal pump will wreck itself. Another point is the absence of vibration; consequently light and inexpensive foundations only are required for such a unit—incidentally this means a small amount of floor space required.

Practically the only bar to the continuance of efficiency by a centrifugal pump is leakage back from one stage to another, or, in the case of a single-stage pump, leakage back to the suction side. The labyrinth rings are a development of years of experimenting, and it has been found that with this type of ring the leakage is practically nil. Of course, in water containing a certain amount of grit, there will be some leakage which necessarily grows worse as time goes on. In order that the pump may be brought back to its original efficiency, the only operation necessary will be to renew the labyrinth rings.

Peculiar Gas-Engine Accident

An accident to a gas engine at Public School No. 130, Brooklyn, produced the remarkable results shown in the photograph. This was a 15-hp. two-stroke-cycle engine, operating on illuminating gas with hot-tube ignition and belted to a ventilating fan. Hit-and-miss governing was employed and at the time of the accident the engine appeared to be running perfectly.

The bedplate cracked square across and buckled, jackknife fashion, enough to allow the piston to pull out of the cylinder and land on top of the latter, where it continued to reciprocate due to the flywheel momentum. This was the condition in which the engineer found it when he entered the room to close the throttle. After the piston had pulled out the bedplate settled back on the foundation. The only other



ENGINE SHOWING PISTON ON TOP OF CYLINDER AND BROKEN EXHAUST PIPE

damage was a broken piston ring, a broken exhaust pipe and water connection. Also, the governor rod snapped after it had been bent up by the buckling action of the engine.

The initial cause of the accident is a matter of conjecture, one theory being that water, due to condensation in the gas line, had come over into the cylinder in sufficient quantity to produce the effect noted. It might be mentioned in this connection that although there is a drain in the exhaust box there was none in the gas line close to the engine. Again it has been suggested that preignition may have been the cause. Comments on the probable cause are solicited.

A Cement for Making Repairs on Switchboards when iron or other metal has to be fastened to marble may be made from 30 parts plaster of paris, 10 parts iron filings and ½ part sal-ammoniac. These are mixed with acetic acid to form a thin paste. This cement must always be used immediately after being mixed, as it solidifies if allowed to stand for any length of time.—"American Machinist."

Feeder Accident Puts Cleveland in Darkness

A large part of the business section of Cleveland was without electric service for many hours as the result of a mysterious fire in the cable subway and manholes at Ontario St. and Vinegar Hill, a few hundred feet from the Canal Road plant of the Cleveland Illuminating Co. The accident occurred about 2 a.m., Tuesday, Dec. 15, and it was not until Thursday night that full service was restored through the stringing of temporary cables. In the meantime many factories were without power, hotels and office buildings were without elevator service or light, and several thousand people were rendered idle.

The 22 one-million circular-mil and six two-million circular-mil cables, which were put out of service, are carried overhead from the power house, a distance of about 400 ft.; then they descend along a wooden pole to the manhole and subway at Vinegar Hill. The manhole covers were blown off, and when the firemen arrived the interior was like a furnace, several hours elapsing before the fire could be put out completely and the smoke from the burning insulation in the ducts cleared away.

The cause of the accident does not appear to have been determined, although a thorough investigation is being made by the company.

TRADE CATALOGS

The Hayden & Derby Mfg. Co., 119 West 40th St., New York. Catalog D-1. Metropolitan injectors, H-D injectors and jet apparatus. Illustrated, 62 pp., 6x9 in.

The Imperial Brass Mfg. Co., 1200 West Harrison St., Chicago, Ill. Catalog No. 92. Heating specialties for vacuum and graduating systems. Illustrated, 32 pp., 6x9 in.

National Tube Co., Pittsburgh, Penn. Circular. Kewanee union, male and female pattern. Illustrated.

Goldschmidt Thermit Co., 90 West St., New York. Pamphlet. Thermit process of pipe welding. Illustrated, 24 pp., 6x9 in.

NEW PUBLICATIONS

THE ANALYSIS OF COAL WITH PHENOL AS A SOLVENT, by S. W. Parr and H. F. Hadley, has just been issued as Bulletin No. 76 of the Engineering Experiment Station of the University of Illinois.

This bulletin shows that by means of phenol, bituminous coal may be divided into two main portions. A study of each division can therefore be carried on to much better advantage than when in the combined state. In general it has been found that the resinic or pitch-like material is soluble in phenol, that it possesses substantially all of the coke producing ingredients, that oxidation destroys the coking property, that this oxidation occurs slowly at ordinary temperatures and proceeds much more rapidly at 212 deg, F. The insoluble material or cellulose residuum is a more active absorber of oxygen; it has no coking property but resembles the lignitic coals in this respect as also in its avidity for oxygen. It is, therefore, to be considered as the constituent most actively involved in spontaneous combustion, deterioration and other difficulties attending the storage of coal.

Copies of Bulletin No. 76 may be obtained gratis upon application to C. R. Richards, Acting Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

THE ORIGIN OF COAL. By David White and Reinhardt Thiessen, with a chapter on the Formation of Peat by Charles A. Davis. Published by the Bureau of Mines; 390 pages, 54 illustrations; paper; 6x9 in. Bureau of Mines Bulletin No. 38.

The purpose of the investigations recorded in this bulletin was to learn by "microscopic examinations of coals, how far and in what ways the grouping of coal by types depends on differences in the kinds of plant material from which it was formed and on the conditions of its accumulation, or how far the special characters or qualities of coal of any type were determined by the nature and state of the plant débris from which the coal was formed.

The opinion that coal is transformed peat is held by the authors. The report is quite thorough in that coals and peat from the various sections of this country have been critically studied under the microscope.

Under a historical review, Mr. Thiessen considers the more important of the investigators of the compositions of coal.

To geologists and related scientific men the book should be of deep interest, but we do not believe engineers will find it of professional value.

TURBINEN MIT DAMPFENTNAHME. A contribution to the study of bleeder turbines, by Dr. August Kriegbaum. Published by R. Oldenburg, Munich and Berlin. 6½x9½ in., 130 pages, 98 illustrations. Paper. Price, 4½ marks.

The author of this book has not attempted to write about steam turbines in general, but has restricted himself to bleeder turbines. This type of turbine is only to be considered in plants where power production and heating are to be combined.

Sizes required, efficiency, steam consumption and many other values depend largely upon the pressure of the steam to be used for heating and the proportion of the quantity of heating steam to the quantity of steam entering into the turbine. These and other points the author examines carefully in the two chapters of this book.

The present types of turbines he divides into two groups, namely, nozzle turbines with few and guide-blade turbines with many stages. In the first chapter, with the use of mathematical formulas and graphical methods, the conditions are laid down for the velocity in the different stages of a Curtis turbine in order to obtain the highest efficiency with relation to the steam pressure which is to be drawn from the turbine for other industrial purposes. By careful investigation it may be determined when and at what point one turbine system is to be preferred to the other in respect to efficiency. Diagrams further explain the influence of the quantity of steam to be drawn upon the output of the turbine, also upon the steam and heat consumption for combined plants, as well as separate power-producing and heating plants.

In the second chapter the behavior of a steam turbine is examined in respect to the usual regulating methods for changing load conditions. These examinations have the further object of determining what conditions are important to economical operation, and are based upon the exact definition of the change of state of the steam when flowing through the turbine. Extensive graphical methods with the help of the Mollier J-S diagram are used.

The author has contributed considerable to the study, design and construction of the bleeder type turbine, so that the book should prove valuable to designers and to students who want to specialize in this type of steam turbine. The fact that the entire work is strictly theoretical will probably keep the practical power-plant man from reading it unless he is interested in this particular subject.

BUSINESS ITEMS

Arthur E. Jackman has been appointed manager of the machinery department of the Walter A. Zelnicker Supply Co., of St. Louis, vice J J. Hilpirt, resigned to become storekeeper of Cia. Mexicana De Petroleo, "El Aguilla" S. A. at Tampico, Mexico. Mr. Jackman has had wide experience gained as general manager of the Sea View R.R. and Narragansett Pier E. L. & P. Co., was for years in the R. & L. Dept. of the Westinghouse Electric & Manufacturing Co. and latterly superintendent of the East St. Louis, Columbia & Waterloo Ry., which position he left to assume his present duties.

Tripp Metallic Packing, manufactured by Wm. B. Merrill & Co., 3368 Washington St., Jamaica Plain, Boston, Mass., will be supplied for all piston rods and poppet valve stems of the three new pumping engines, now being built for the City of Cleveland. This company is also building metallic packing for 16-in. gas rods and 16-in. air rods of engines now being constructed for the Pennsylvania Steel Company, Steelton, Penn.

The Ohio Blower Co., 5130 Perkins Ave., Cleveland, Ohio, has just issued a handy booklet containing some sheet metal and angle iron suggestion's for factory superintendents, efficiency engineers and contractors. It is called the Handiline Handibook—contains many illustrations—and is sent for the asking.

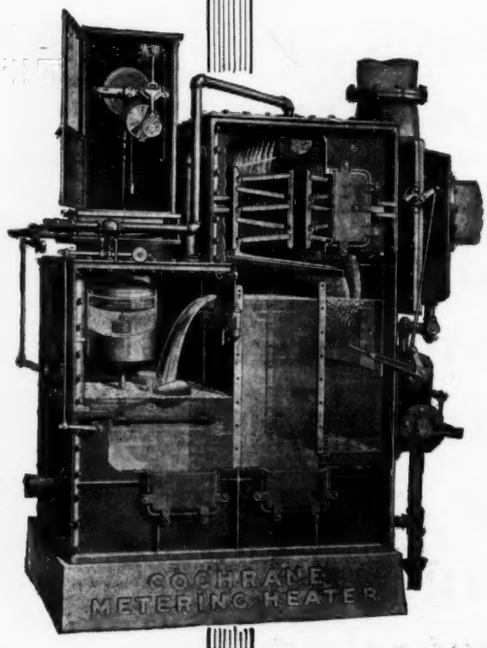
It having been brought to its attention that rumors were being circulated that it intended to retire from the piping business, the Best Manufacturing Co., of Pittsburgh, Penn., wishes to emphatically deny these rumors and assures the trade that it is now and intends to continue aggressively prosecuting the piping business.

Benjamin G. Fernald has resigned as sales manager of the Best Manufacturing Co., Pittsburgh, Penn., in order to enter business in New York City about the first of January.

A. E. Seelig has been appointed general sales manager of the Kerr Turbine Co., Wellsville, N. Y., and John A. Hense, St. Louis representative. Mr. Seelig for several years held a similar position with the L. J. Wing Manufacturing Co., and more recently managed the new machine tool department in the New York office of Schuchardt & Schutte. Mr. Hense was formerly with the National Malleable Castings Co., Chicago, and later with the Dravo-Doyle Co., of Philadelphia.

IN THIS SPACE will appear next week an announcement of vital importance to every man who is interested in removing scale from his boilers, preventing the formation of new scale, stopping pitting and foaming, and increasing the life of the boilers.

RUN AN EVAPORATION TEST EVERY DAY



The Cochrane Feed Water Meter method of buying coal is superior to the coal analysis or the calorimeter, as it tells the owner or the chief engineer directly how much his steam is costing him.

Noting low evaporation, he will naturally seek the cause, as bad combustion conditions, leakage of air through settings, scale and soot on heat transmitting surfaces, excess of air, loss of fuel through grates, incomplete combustion, etc., etc.

These are the economy times, and a little scientific management in the boiler room will help your standing.

The **Cochrane Metering Heater** (Combined Open Feed Water Heater and Hot Water Meter) assists in improving the plant efficiency by heating the boiler feed water by means of exhaust steam. It is more simple and compact than a heater plus an independent meter, although a Cochrane Independent Meter installed in accordance with our patents will give all the other advantages of a metering heater, such as the ability to meter water under back pressure conditions, or with fluctuating supply of exhaust steam to the heater.

Don't take the coal company's word as to how good the coal is. Run your boiler plant on a "Show-Me" basis. Even if a coal analysis or calorimeter test is correct and applies to the coal you are actually burning, it does not tell you how many heat units you are putting into the boiler.

Install a Cochrane Feed Water Meter, and get everybody interested, all the way from the coal man to the fireman, the chief engineer and the boss, in beating the record for low cost of steam. It will pay.

Ask for our booklet on "Hot Water Meters and Their Practical Applications."

HARRISON SAFETY BOILER WORKS

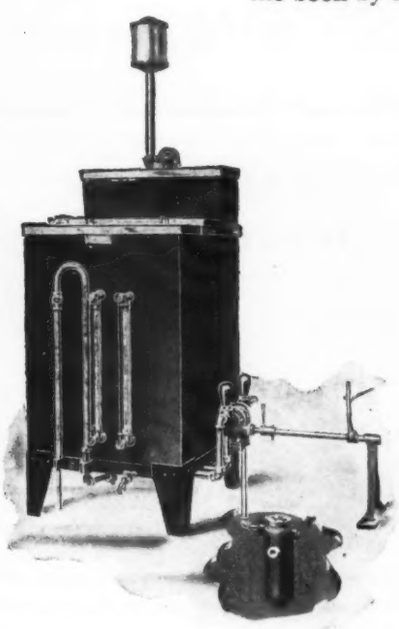
17th & Clearfield Streets, PHILADELPHIA, PA.

"Everything For Lubrication But The Lubricants"

2% Increase in Efficiency Will Save $375.00 per Year per 1000 H.P. in Fuel

Want to know how we figured that out? We haven't room to tell you here, but it is all figured out in detail on page 9 of our book M 55, "Scientific Lubrication of Machinery." Furthermore, this book tells how to increase your engine efficiency 2 to 10%, reduce your oil bills 50 to 75% and cut down attendance costs.

Your name on a post card will bring the book by return mail.



Essential Features of a Richardson Individual Oiling and Filtering System. It's extremely simple. Any engineer can install one in a few hours. These systems always pay for themselves in less than a year.

50 pages of worth-while information on the application of oil to power plant machinery. You would be glad to pay for the book just to get the chapter on "The Nature and Choice of Lubricating Oils," but we'll send it free of charge.

THE RICHARDSON-PHENIX CO.

LUBRICATION ENGINEERS AND MANUFACTURERS

WORKS-124 RESERVOIR AVE. MILWAUKEE, WIS.

199

EUREKA
PACKINGS

FOR ALL PRESSURES – LOWEST TO HIGHEST

For:
Sulphuric Acid Systems,
Superheat,
Crude Oil,
Oil,
Ammonia, etc.

When your packing troubles become too numerous buy Eureka Packings. Many engineers save themselves trouble and get better results in that way.

THIS LABEL ON PACKING IS A GUARANTEE OF EXCELLENCE. PATENTED "EUREKA" TRADE MARK.

SINCE 1879

EUREKA PACKING CO.
76-77 Murray St., New York

AUTOMATIC ENGINES
In Stock. A1 Condition.

150 H.P. RICE
60 H.P. PHOENIX
40 H.P. CHUSE

Generators, Motors, Pumps, Hoists, Loco Cranes, Industrial Locomotives, Steam, Gas or Electric, any Weight and Gauge, Rails and Turntables.

Get Our 84-Page Bulletin

ZELNICKER — WALTER A. ZELNICKER SUPPLY COMPANY — St Louis

For Long List of Bargains.

Put It Outdoors If Desired—

No danger of the SARCO Trap freezing in cold weather. It never freezes or sticks.

SARCO

Write for the reasons why this trap is better. Do it today.

Sarco Engineering Co., 116 Broad St., New York
Chicago Office: Old Colony Building

"Lion" Is a Strongly Reinforced Packing

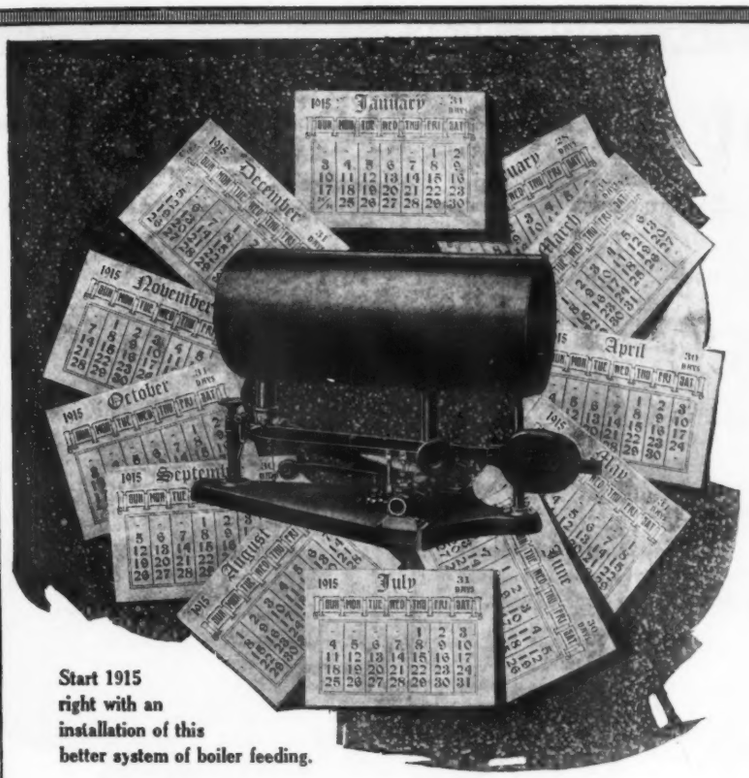
Lion Metallic Packing is literally reinforced. It has metal studs extending through its fibre and providing a wear surface. It is elastic.

Write for Catalog. Look for "Thin Red Line" when buying.

James Walker & Company, Ltd.
27 Thames Street New York City

AGENTS—J. & R. Wilson, Inc., San Francisco, Calif., Sole Western Agents; Curry Bros. Co., 284 Franklin St., Boston, Mass.; Tiffany Vogel Co., 332 Third Ave., Pittsburgh, Pa.; Economic Engineering & Supply Co., Spingarn Bldg., Jersey City, N. J.; O. C. Keckley, 139 North Clark St., Chicago, Ill.

No matter whether you have charge of a small plant or a large plant there is some idea in the advertising pages each week that will help you secure better results. Careful study of the advertising pages pays —and pays big.



Start 1915 right with an installation of this better system of boiler feeding.

Automatic Feeding of Your Boilers the Whole Year 'Round with Water Previously Wasted is One Benefit Obtained Through an Installation of the

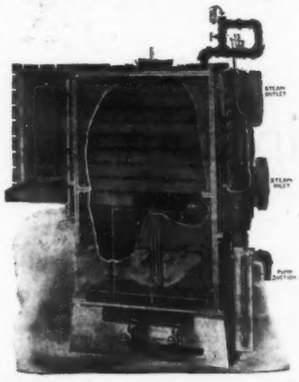
Morehead Back to Boiler SYSTEM

Condensation! Are you draining it out of your steam apparatus and returning it to the boiler as feed water? The "Morehead System" will do it for you—will create a profit out of this previously wasted *hot* water by feeding it *direct* to your boilers *at its initial temperature.* Figure the saving in time, fuel and labor. It's real economy, isn't it? And you can prove every statement we make in your plant *any time.* Write us *now* for complete information. You'll find it pays.

Morehead Mfg. Co. Dept. "E" **Detriot, Michigan**

267

Before Purchasing a Feed Water Heater



ask yourself these questions:

Has it, 1—Long water travel, 2—Large tray surface, 3—Scale in heater, not in boiler? And then consider that

The "Stickle" Heater and Purifier

answers all these requirements.

Send for descriptive matter.

Open Coil Heater & Purifier Company
502 S. Pennsylvania Street
Indianapolis, Ind.

Boston Office, 518 Oliver Bldg. New York, John Simmons Co. Fitchburg, Mass., The G. M. Parks Co. Philadelphia Office, The Bourse, (Machinery Dep't).

McDANIEL IMPROVED Steam Trap

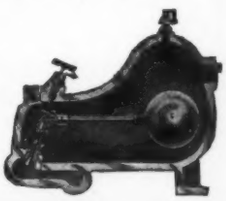
FOR HIGH OR LOW PRESSURE

Steam can't blow through. They have large discharge valves and cannot be flooded from sudden flushes of water.

MAY WE SEND ONE FOR TRIAL?

We also manufacture

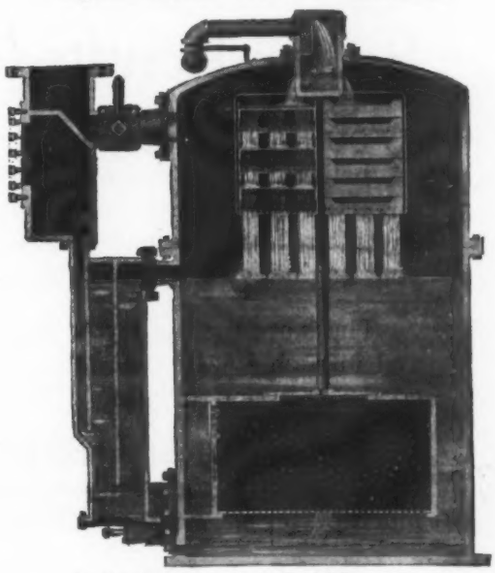
Reducing Valves, Pump Governors, Relief Valves, Exhaust Pipe Heads, Ejectors and Steam Separators. SEND FOR CATALOGUE.



Watson & McDaniel Company,
137 N. 7th St., Philadelphia, Pa.

MASSILLON

Open Feed Water Heaters



Section of Massillon Open Feed Water Heater

represent the latest and best practice in pre-heating and purifying boiler feed water.

Bulletin 211 tells all.

The Griscom-Russell Co.
Engineers—Manufacturers—Land and Marine
2116 West St. Bldg., New York
Successors to The James Reilly Repair & Supply Co., The Griscom-Spencer Co., and The Russell Engine Co.

DURABLA-TIZE YOUR PLANT

If the joint is to be tight—

The gasket must be of the right material—the right thickness—**and applied right.**

The combination of these three is what constitutes—

DURABLA SERVICE

Durabla Gaskets—right thickness—applied in the Durabla way.

We sell more than "just packing." Our specialty is selling a service that puts an end to leaky joints—a guaranteed service.

Durabla Service Men will be glad to **show** you how to make all the joints in your plant tight—by intelligent use of Durabla Gaskets.

Write us.

Durabla Mfg. Company

114 Liberty St., New York

Branch Offices in Pittsburgh and Chicago

Better Results from Your Equipment

YOU may have been doing your work week after week in the same way, believing that you were getting the best possible results. But this is a mighty swift age and new methods of doing things are being invented day after day—methods which help you get better results from your boiler, your engine, your entire equipment.

These are methods you should know about—they are always advertised and in such a way that it's a rare advertising page that will not yield one good suggestion to you.

Suppose you read the advertising pages of this issue thoroughly and see how many methods suggest themselves to you by which you could make a much better showing, by which you could save time and expense—then act.

This Service Helps You Economize

Keen thinkers and practical workers have brought the average power plant to a high point of efficiency. The big, inexcusable wastes have been eliminated.

The smaller leaks are sometimes overlooked on account of their apparent insignificance yet they often aggregate a tidy sum at the end of the year. To help you in the search for these leaks and to suggest the remedies for them is only one of the many functions of

Johns-Manville Service to Power Plants

On each of our products we have experts who know the practical problems arising in the power plants. These men have given special study to the small leaks and have helped save thousands of dollars for power plants throughout the country.

We offer you the service of these men without obligation and also call attention to the following products, each one of which is made to meet a definite need in the most efficient and economical way—

J-M Kearsarge Standard Gaskets

For manhole, handhole or tube plate service. Economical because they can be used over and over again. Made of Asbestos and cannot burn out, blow out or squeeze out. Light in weight and durable.

J-M Universal Piston Packing

A piston packing entirely different from the hydraulic style of packings usually used for this purpose. J-M Universal will not break up and work into parts of the pump. Moulded to exact size. Resilient and durable.

J-M Permanite Sheet Packing

Makes a tight joint on any flange—no matter what the conditions are. It is made of Asbestos fibres bound together with a special heat-resisting compound that 1000 degrees of heat will not affect. Withstands any pressure.

Write nearest branch for descriptive booklets.

H. W. JOHNS-MANVILLE CO.

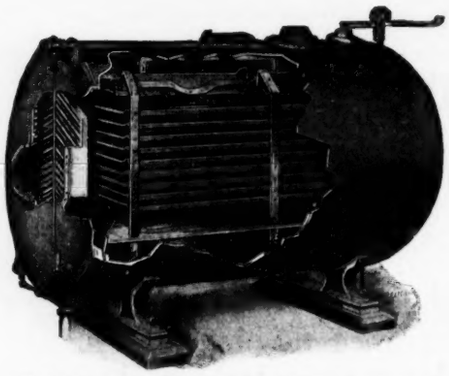
Manufacturers of Pipe Coverings; High Temperature Cements; Boiler Preservative; Conduit; Metallic Hose; Fuses; Boiler Plugs; Stack Lining; Tube Cleaners; etc.

Akron, Albany, Atlanta, Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Columbus, Dallas, Dayton, Denver, Detroit, Duluth, Galveston, Houghton, Houston, Indianapolis, Kansas City, Los Angeles

Louisville, Memphis, Milwaukee, Minneapolis, Newark, New Orleans, New York, Omaha, Philadelphia, Pittsburgh, Portland, Rochester, St. Louis, St. Paul, Salt Lake City, San Francisco, Seattle, Syracuse, Toledo, Washington, Wilkesbarre, Youngstown

THE CANADIAN H. W. JOHNS-MANVILLE CO., LIMITED, Toronto Montreal Winnipeg Vancouver

2960



HOPPES

Feed Water Heaters

Have a large heating and lime-catching surface which is the most essential feature of any efficient Heater. In addition to this they bring the water and steam together in the most effective manner, the water flowing constantly in thin films in direct contact with the steam, thereby insuring the highest possible temperature and best purification to the feed water. Hoppes Heaters are equipped with large and efficient oil separators and an automatic and accurate feed water control, and all parts are easy of access and can be readily cleaned and kept in first class condition. Hoppes Heaters are built in either Steel or Cast Iron construction and with or without extra water-storage capacity, as may be desired.

Hoppes Steam Separators

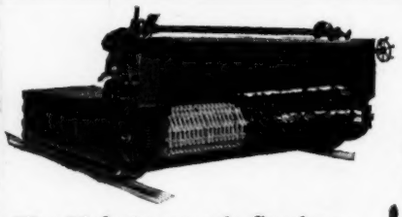
Have a principle of their own—the intercepting troughs partly filled with water, which guard the ports, checking the creep of the entrainment and preventing its being atomized. and carried on with the steam They are built in all types and sizes.

Hoppes Oil Eliminators

Thoroughly eliminate the oil from the exhaust and make the condensate suitable and valuable for boiler feed. When used in connection with low pressure turbine units, they keep the oil and water from the blades and greatly increase the efficiency and durability. All types and sizes.

Write for special catalog and particulars.

THE HOPPES MFG. CO.
19 Larch Street SPRINGFIELD, OHIO



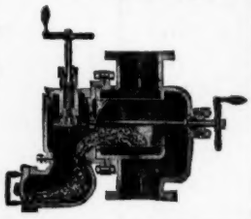
The Playford Chain Grate Stoker

for heavy duty power plant service. Descriptive literature upon request.

The Holt Automatic Strainer

for removal of solid foreign matter from water supply lines.

No interruption of flow through lines.
No removal of parts for cleaning.
Bulletin S upon request.



Rosedale Foundry & Machine Co.
Pittsburgh, Pa.

Copper Coated Seamless Floats

On a Naugatuck Float made with a steel core there's a heavy seamless coating of the Best Lake copper which makes it strong and tight.

The core is of steel and naturally the float is not as expensive as the all-copper float. Made for any desired pressure.

Write for book and prices.

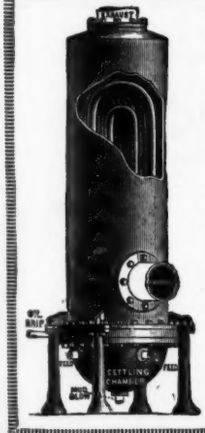
Naugatuck Mfg. Co., Naugatuck, Conn.
440 North Main Street

IF YOU don't know how much you save by heating your feed water in a

NATIONAL

Write to

The National Pipe Bending Company
168 River St. New Haven, Conn.
Ask for Catalog No. 51 46-33



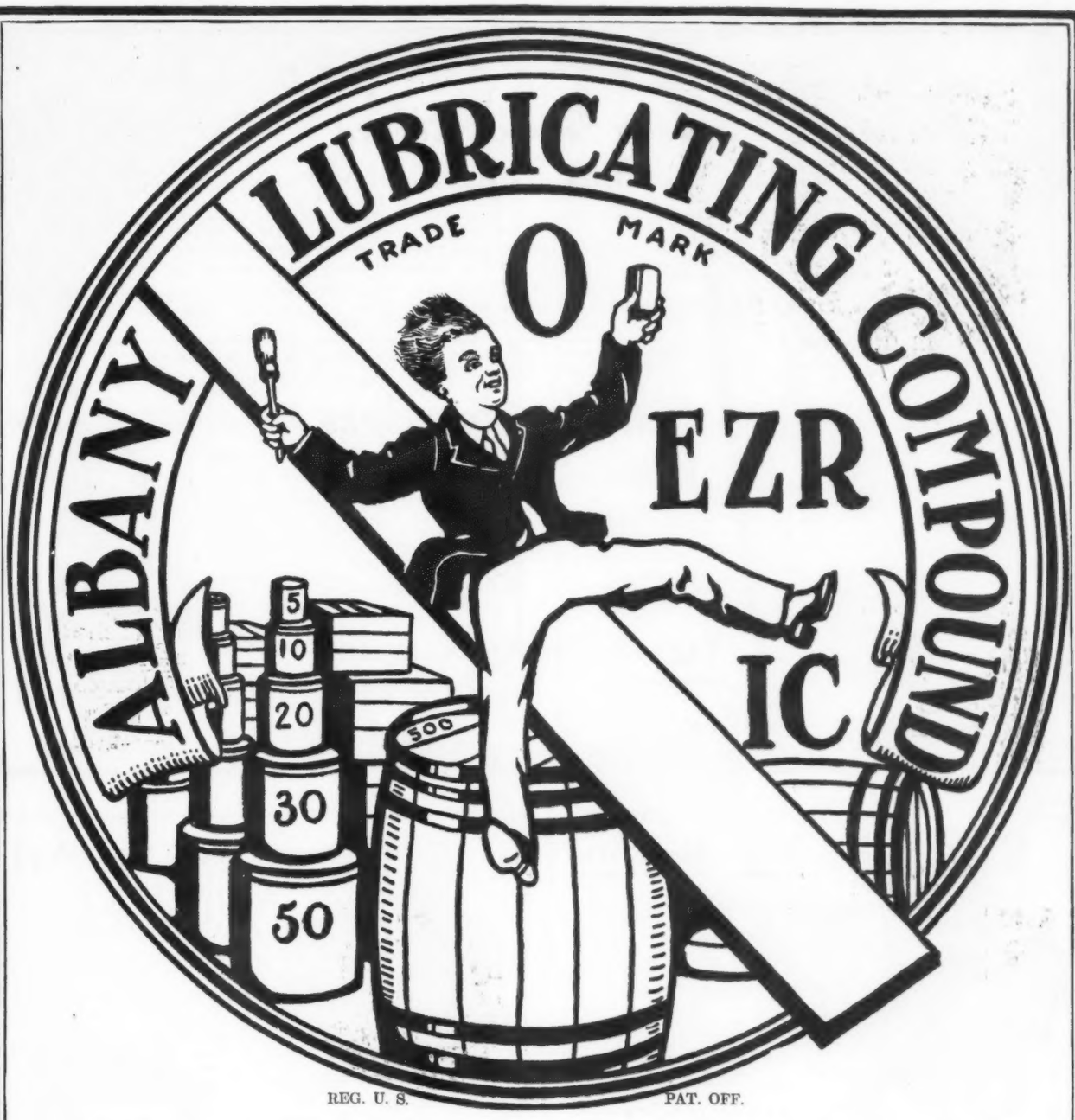
INCREASE

the steaming capacity of your boilers by installing the PATTERSON-BERRYMAN FEED WATER HEATER AND PURIFIER.

Saves coal—reduces boiler wear and tear—saves on repair bills. 60 days' trial. Investigate. Write for catalog.

Frank L. Patterson & Co.
28 Cortlandt St., New York

Also Manufacturers of Hot Water Heaters of all styles, for all purposes, for use with exhaust or live steam, or in connection with low pressure heating systems.



REG. U. S. PAT. OFF.

Our Trade Mark showing the boy sliding down the plank appears on every package of the genuine Albany Grease. There is only one Albany Grease and it is made only by us. Permit no one to tell or sell you different. The Trade Mark is your guarantee of perfect lubrication service.

ALBANY GREASE

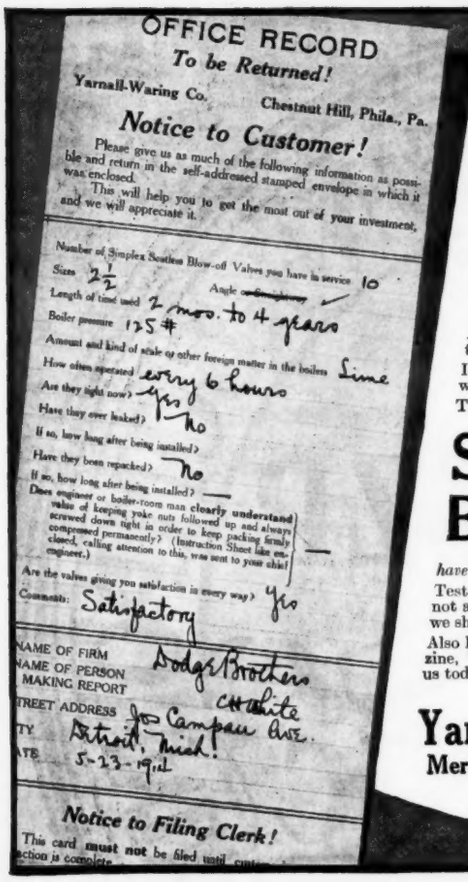
If you are not using Albany Grease in your plant at present—now is the time to start. If you have any doubts as to just what Albany Grease can do, let us send you enough for a trial. There will be no charge. An Albany cup and our book "Friction" will also be sent. Write—now.

Your dealer sells Albany Grease—if not, order direct.

Albany Lubricating Co.

Adam Cook's Sons, Props.

708-10 Washington St. New York


OFFICE RECORD
To be Returned!
Yarnall-Waring Co. Chestnut Hill, Phila., Pa.
Notice to Customer!
Please give us as much of the following information as possible and return in the self-addressed stamped envelope in which it was enclosed.
This will help you to get the most out of your investment, and we will appreciate it.
Number of Simplex Seatless Blow-off Valves you have in service 10
Sizes 2½ Angle
Length of time used 2 mos. to 4 years
Boiler pressure 175#
Amount and kind of scale or other foreign matter in the boilers Lime
How often operated every 6 hours
Are they tight now? yes
Have they ever leaked? no
If so, how long after being installed?
Have they been repacked? no
If so, how long after being installed?
Does engineer or boiler-room man clearly understand value of keeping yoke nuts followed up and always screwed down tight in order to keep packing firmly compressed permanently? (Instruction Sheet like enclosed, calling attention to this, was sent to your chief engineer.)
Are the valves giving you satisfaction in every way? yes
Comments: Satisfactory
NAME OF FIRM Dodge Brothers
NAME OF PERSON MAKING REPORT C.H. White
STREET ADDRESS 300 Campau Ave.
CITY Detroit, Mich.
DATE 5-23-1911
Notice to Filing Clerk!
This card must not be filed until section is complete

A Service Record That Tells a Story

—"help you to get the most out of your investment." Do you notice that line on this Office Record Card? That is one point behind every sale we make; we expect you to get more for your money than you could by purchasing any other blow-off valve on the market. If you do not, this card finds out why.

About two months after you buy a Simplex Valve, you will get a blank and just like that at left asking whether you are absolutely satisfied.

It is an illuminating fact, that of all of these cards sent out, practically every one comes back with a "yes" after that question, and usually, as in this case still stronger indorsements are added.

The reason for this is that

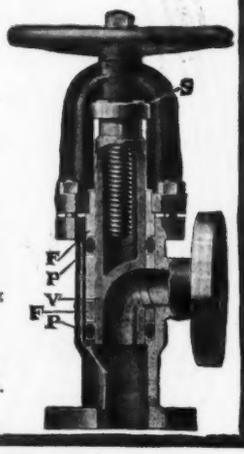
Simplex Seatless Blow-Off Valves

have no seat to leak.

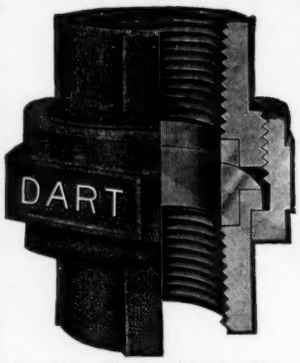
Test a Simplex Blow-Off Valve for 60 days and if you are not able then to fill out just as favorable a report as the one we show here, return the valve.

Also let us put your name on the list to receive our magazine, "The Blow-Off." No obligation, so will you write us today?

Yarnall-Waring Company
Mermaid Ave., Chestnut Hill, Philadelphia



Description: In closing valve, shoulder S on plunger V engages the loose follower gland F, compressing packing P above and below the port, making an absolutely tight valve.



Try It Now

on that most troublesome pipe line—that **free sample** we want to send you of the

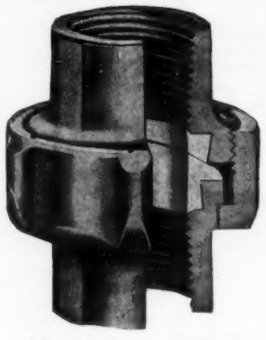
Dart Union

The Bronze to Bronze seats eliminate corrosion and prevent leaking.

Write for new catalog

Ask your dealer for prices.

E. M. Dart M'f'g Company, Providence, R. I.
The Fairbanks Company, Sales Agents
Canadian Factory: Dart Union Co., Ltd., Toronto.


Why You Will Like the Rockwood

You will like this union because it is made of pressed steel and has *two* bronze seats forced into place under enormous pressure.

Because it is rustproofed by the sherardizing process.

Write for circular.

Rockwood Sprinkler Co. of Mass.
Worcester, Mass.

FORBES Threading Machines

They save you the cost of from two to six laborers. They cut threads without burr. They are economical to operate.

Send for catalog describing application in your plant.

The Curtis & Curtis Co.
85 Garden Street
Bridgeport, Conn.

THERE is nothing mysterious about the wonderfully close and accurate regulation of a MASON REDUCING VALVE. It is an open book—and worth looking into. Just write for a copy of our Mason Reducing Valve Book.

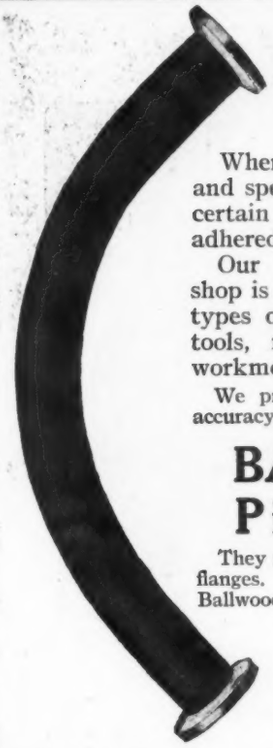
Mason Regulator Co. Adams and Medway Sts., BOSTON, MASS.

Never Get Stuck

New Bedford Whale Brand Valves are as perfectly constructed as it is possible for valves to be regardless of cost.
Do yourself the justice to investigate.

New Bedford Valve Manufacturing Co.,
Established 1872 New Bedford, Massachusetts

"Safety" Plastic
METALLIC PACKING
For Steam, Water, Air, Gas, Etc.
SELF LUBRICATING. FRICTIONLESS.
ANY QUANTITY SENT ON APPROVAL. SEND FOR FREE SAMPLE.
Steel Mill Packing Co.
Detroit, Mich., U. S. A.



Let Us Furnish Your Piping

When you submit your plans and specifications to us you are certain that they will be rigidly adhered to in every detail.

Our large modern bending shop is equipped with the latest types of furnaces and machine tools, manned by experienced workmen.

We pride ourselves upon extreme accuracy in the production of

BALLWOOD Pipe Bends

They may be fitted with any type of flanges. We strongly recommend that Ballwood Welded Flanges be employed on superheated steam lines.

Our engineering department will gladly furnish particulars. Write for interesting Booklet now.

The Ballwood Company

Passaic, N. J.

Sales Office—30 Church St., New York

Parts for Ball and Wood Engines. General Machine Work.

"Toledos" Doing Easily a Hard Job

It was an easy matter for this engineer to do, with his Toledo No. 2, this otherwise impossible job. He found it necessary to cut a four-inch thread on a pipe projecting between an iron tank and a brick wall in just 10 inches of clear space. His "Toledo" solved the problem. It threaded the pipe right in position, easily.

Toledo Pipe Threaders

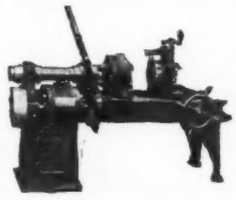
will solve your pipe threading problems. They will enable you to do any job of threading around the plant and do it easily, with the pipe kept in position.

Write your name and address on the margin, and mail us this ad for catalogue.

THE TOLEDO PIPE THREADING MACHINE CO.
TOLEDO, O.
New York Office, 1182 Broadway

If You Have Any Pipe Threading to Do

You should investigate B & K Pipe Threading Machines for you can use them to great advantage. They work rapidly and are extremely easy to operate. The threads are always clean and accurate. Made in nine sizes, each size having a capacity of from 8 to 10 sizes of pipe. All machines equipped with the Peerless Die Head.



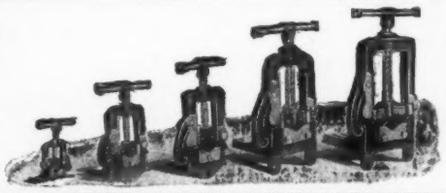
Write for Catalogue

Bignall & Keeler Machine Works
Edwardsville, Ill. 1-4

MALLEABLE IRON HINGED PIPE VISES

Manufactured by

The Armstrong Mfg. Co.
287 Knowlton St. Bridgeport, Conn.



"The BARNES" LATHES

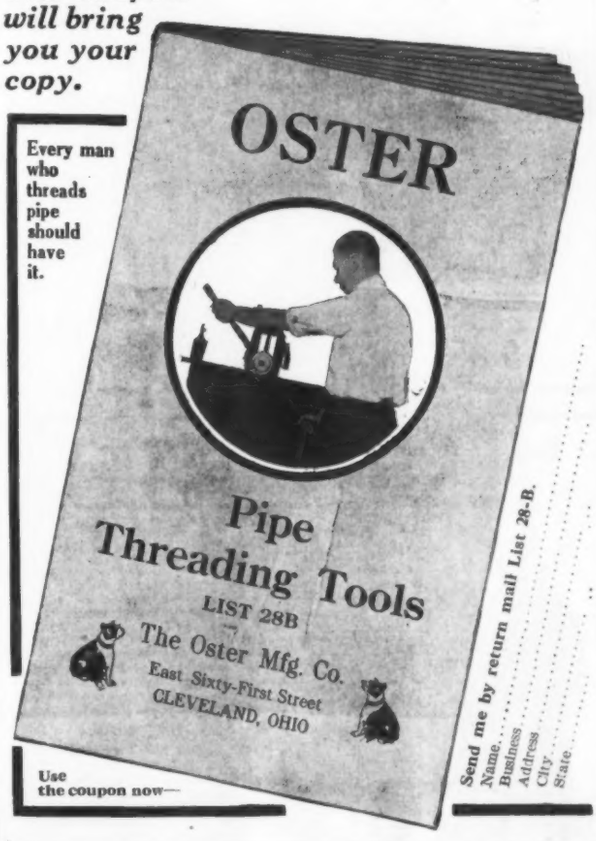
9 in. to 18 in. Swing

No. 4½ Lathe, 9 in. x 25 in., List $ 75.00
No. 5 Lathe, 11 in. x 34 in., List 100.00
Our 13 in. lathes made 5 to 10 feet long. Send for lathe catalog.

W. F. & John Barnes Co., 990 Ruby Street, Rockford, Ill.

The coupon will bring you your copy.

Every man who threads pipe should have it.



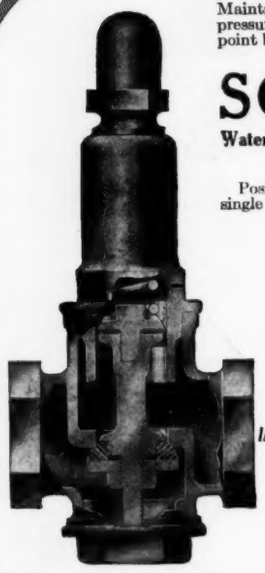
Use the coupon now—

Send me by return mail List 28-B.
Name.....
Business.....
Address.....
City.....
State.....

"SCHADE" POSITIVE SEATING NOISELESS VALVES

Avoid Fluctuating Water Pressures

Maintain your reduced water pressures constant at the desired point by using



SCHADE

Water Pressure Reducing Valve

Positive action is assured by the single disc operated without hammer, chatter or sticking by the **Phosphor Bronze** spring which is not subject to corrosion.

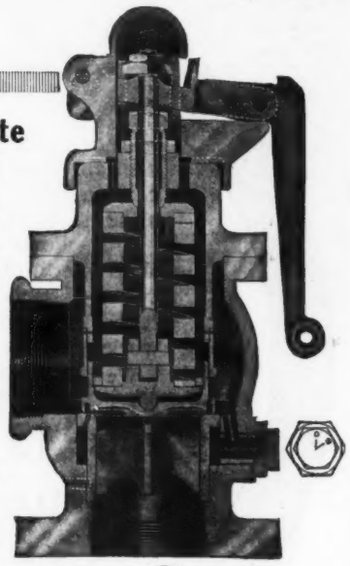
The type illustrated delivers a steady outlet pressure, regardless of variations in the inlet pressure.

The only wearing parts are the disc and balancing piston leathers. Both can be cheaply renewed without removing the valve from the pipe line.

Sent on 30 days' free trial. Write for Catalog today.

Schade Valve Manufacturing Co.
2530 N. American Street, Philadelphia, Pa.

Do Not Waste The Steam



Just because the boilers need relief from excessive steam pressure is no *good* reason why steam should be wasted.

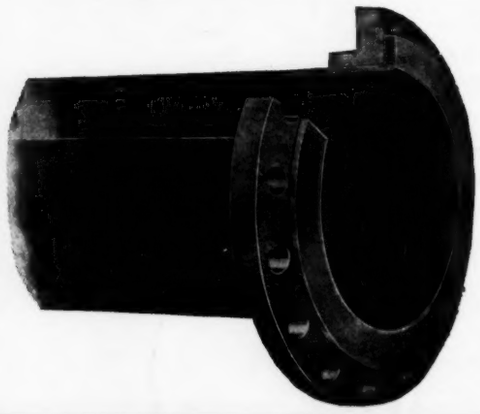
ASHTON Pop Safety Valves

give complete relief with an average drop of only three pounds against the usual five to fifteen pounds in other types.

Our 42 years' experience in the successful manufacture of Ashton Products can be of service to you. Use it.

Write for the "Ashton Book."

The Ashton Valve Company
269 Franklin Street Boston, Mass.
New York, 128 Liberty Street
Chicago, 174 North Market Street



For Maximum Efficiency

on high pressure, high temperature, superheated steam lines—specify

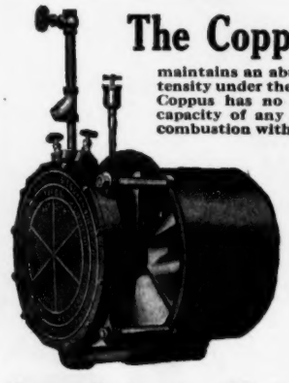
Whitlock Joints

They have no peer in tightness and durability under the heaviest expansion and contraction stress.

Made by a special process of double lapping that insures the full thickness of the pipe at the square corner of the lap. The forged steel flange swivels about the pipe and greatly facilitates erection.

Let us estimate on your complete pipe equipment. Write for catalog today.

The Whitlock Coil Pipe Co., Hartford, Conn.
New York Office, 149 Broadway



The Coppus Turbo Blower

maintains an abundant draft of the correct, even intensity under the entire fuel bed. We believe that the Coppus has no equal for increasing the steaming capacity of any boiler plant by producing efficient combustion with the cheapest grades of coal.

In one case, tested side by side with another make, the Coppus proved that it consumed 50 per cent less steam.

We would welcome an opportunity to test the Coppus against any other blower. We are confident that it will equal the above steam saving in your own boiler room NOW.

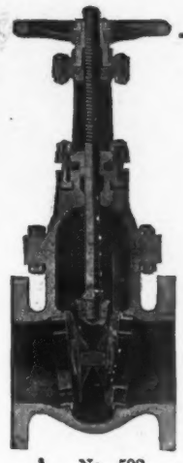
The Coppus has replaced many other blowers but no other blower has ever replaced a Coppus. Write for Catalog today.

Coppus Engineering & Equipment Co., 166 Union Street, Worcester, Mass.

KELLOGG WELDED FLANGES

The flanges on Kellogg Piping are welded in specially designed furnaces. That's why they are better and stronger than piping with ordinary welded flanges. **Get our book—write.**

The M. W. Kellogg Co., 50 Church Street, New York



No. 522
Gate Valve

Valve Performances Without "Ifs" or "Buts"

IN Cleveland, Ohio, there has recently been erected a splendidly-equipped power house by the Cleveland Electric Illuminating Company. Nelson valves were used throughout because the engineers knew that they would do the work without "ifs" or "buts." The equipment included over 80 Nelson Steel Gate Valves alone, ranging in size up to 20″ openings and some weighing 4700 lbs. each.

NELSON Valves

"A Safe Valve Investment"

The same reason—service positively assured—led the Curtis Publishing Company to use Nelson Valves in their splendid new building; also the New York Edison Company, and others, equally well known.

It is for this reason you should find them most economical in meeting your own valve problem, whatever its nature may be.

Not a valve leaves our factory without being triple tested; 1st, to see that the raw material is up to standard; 2nd, to be sure that the rough castings are o.k.; 3rd, to be sure that the finished valve is as perfect as human skill can make it.

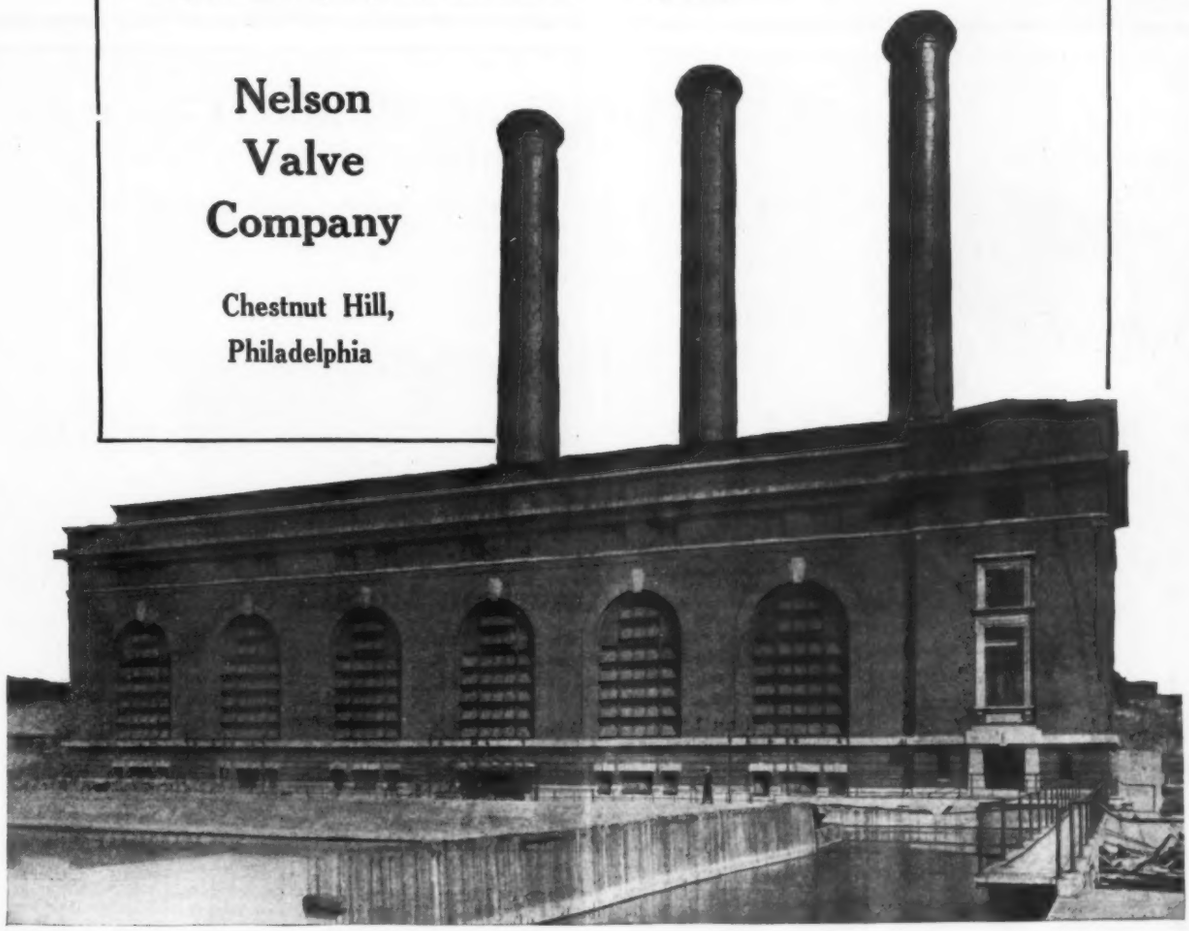
Each bears the Nelson guarantee of satisfactory service.

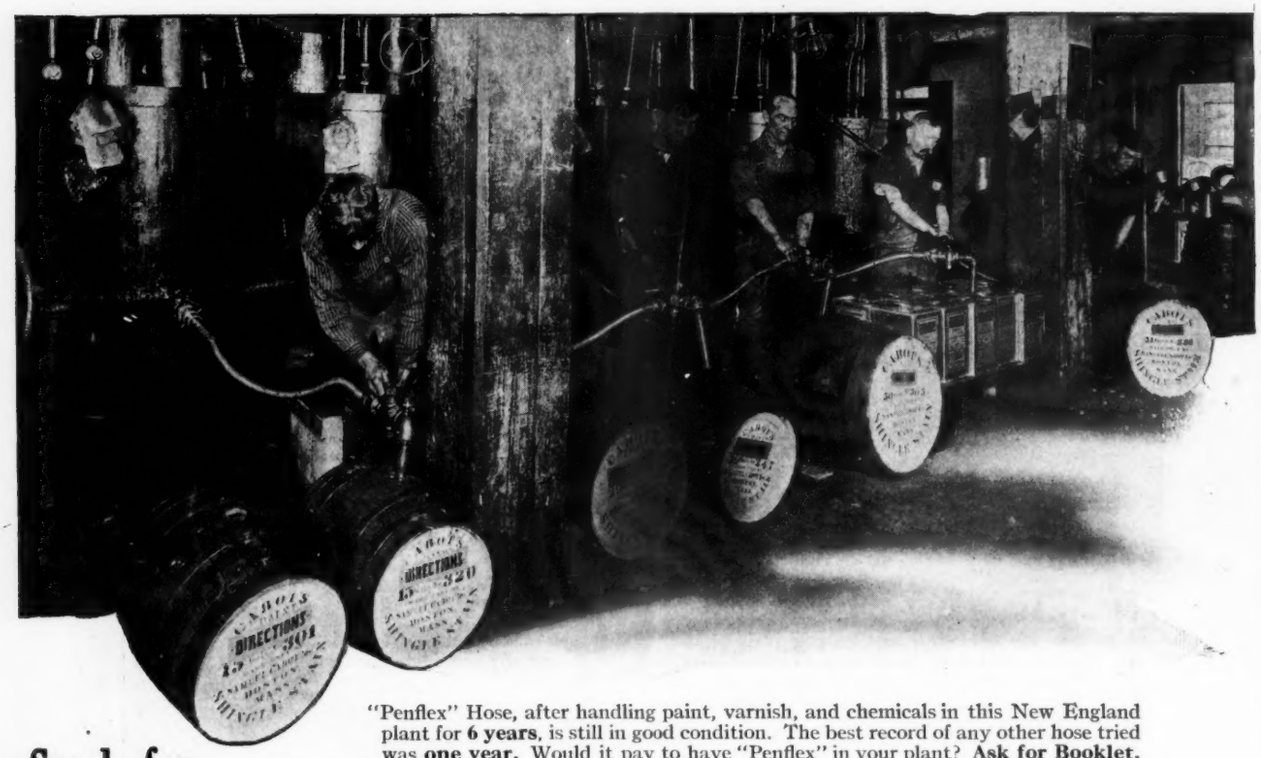
That is the kind of valve service that should interest you.

If it does, write us about the valves you are most interested in and we will send full information without obligation of any kind.

Nelson Valve Company

Chestnut Hill, Philadelphia





"Penflex" Hose, after handling paint, varnish, and chemicals in this New England plant for **6 years**, is still in good condition. The best record of any other hose tried was **one year.** Would it pay to have "Penflex" in your plant? **Ask for Booklet.**

Send for "Penflex" Book

PENNSYLVANIA FLEXIBLE METALLIC TUBING COMPANY

Cor. Broad and Race Sts., Philadelphia, Penn. **Works: 72nd and Powers Lane, W. Philadelphia**
NEW YORK, N. Y.—30 Church St. BOSTON, MASS.—11 High Street. CHICAGO, ILL.—Peoples Gas Building.
U. S. FLEXIBLE METALLIC TUBING CO.
LOS ANGELES, CALIF.—450 East 3d Street. SAN FRANCISCO, CALIF.—63 Main Street.
HOUSTON, TEXAS—429 First Nat'l Bank Bldg. SEATTLE, WASH.—509 Maynard Building.

A Diver's Suit Should Go with Rubber Hose

When boring your boiler tubes with a turbine cleaner at the end of rubber hose haven't you often felt the need of a diver's suit? Haven't you often been nearly drowned when the hose, weakened and worn through by constant chafing on the sharp edge of the tubes, burst without warning and left you shivering with not a dry stitch on your back?

Just as long as you stick to rubber hose this periodical drenching will continue. You can stop it for once and for all by using American Metal Hose.

American Metal Hose

successfully resists the wear and tear of being jabbed down countless tubes. It can be left on hot pipes and boiler settings, without the slightest danger of injury.

American Metal Hose is easier to work with than rubber-hose.

Its construction is mechanically perfect, combining great strength with extreme flexibility. Every length of Turbine Cleaner Hose is reinforced on the end near the cleaner and has double strength at this point which is the spot where the greatest strain comes.

Write for facts and figures on the kind of Hose which you are interested in.

The American Metal Hose Company

Waterbury, Conn.

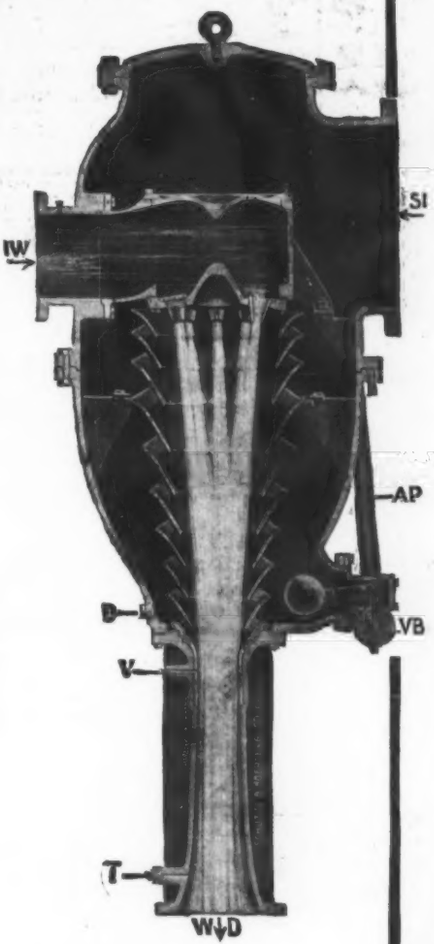
SALES OFFICES: 84 Batterymarch St., Boston, Mass. 29 East Madison St., Chicago, Ill. 173 Lafayette St., New York City.

Koerting Multi-Jet CONDENSERS

The Principal Advantages:

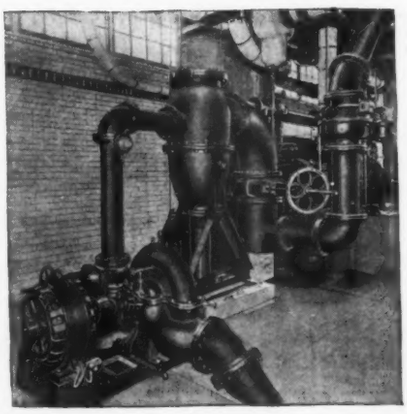
1. **No special air pump required** as condenser and air pump is combined in one apparatus.
2. **Vacuum of 28″ with 70° F. water** referred to a barometer of 30″.
3. **No moving parts to get out of order** or require attention.
4. **Little wear or depreciation.**
5. **Little liability of air leaks** as condenser may be placed as close to engine or turbine as conditions will permit, therefore
6. **Minimum cost for vacuum piping.**
7. **Does not require long tail pipe.**
8. **Placed above or below engine or turbine,** depending only on conditions of plant.
9. **Separate condenser for each unit,** permits of economical operation in winter months when exhaust steam from one or more units is used for heating purposes.
10. **Condenser is low in first cost.**
11. The 11th and additional advantages, complete descriptive data, etc., clearly set forth in our

NEW CONDENSER CATALOGUE 5-AB.



SCHUTTE & KOERTING CO.,

Tompson and 12th Streets
Philadelphia, Pa.

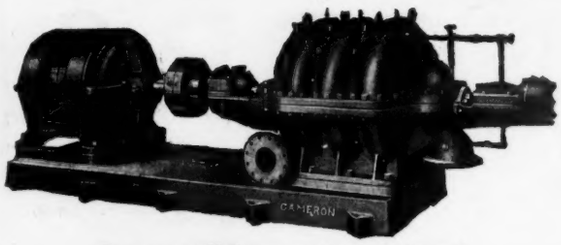


NEW YORK: 50 Church St.
BOSTON: 132 High St.
CHICAGO: Security Bldg.
PITTSBURGH: Keenan Bldg.
CLEVELAND: New England Bldg.
DENVER: 1st Nat'l Bank Bldg.
KANSAS CITY: Burton Mach'ry Co.
DAYTON: Gimperling & Sons.

SCHUTTE & KOERTING CO.
(Send to nearest Branch.)
Gentlemen: Please send copy of your Catalog 5-AB, per advertisement in "Power," to the above address.
..... Engineer
..... Company
..... Town

The Slogan of the Cameron—"Character: The Grandest Thing"

Cameron Centrifugals



Cameron 8" Four-stage Centrifugal

It's the long, steady pulls of pumping, so common in power plant work, that test pumps to the utmost. It's in situations like these that Cameron Centrifugals prove their superiority.

These pumps are extremely simple and compact, and are driven by electric motor or any other motive power.

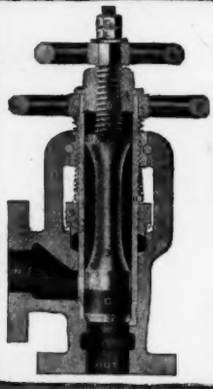
Note the accessibility. Casings are split horizontally so that every working part may be reached without disturbing pipe connections or pump alignment. Built of the finest material. Highest efficiency.

Learn more about them—write for Bulletin No. 151.

A. S. Cameron Steam Pump Works

11 BROADWAY, NEW YORK

Offices the World Over 12-20



Guaranteed Always Tight

Eynon-Evans Blow-Off Valve

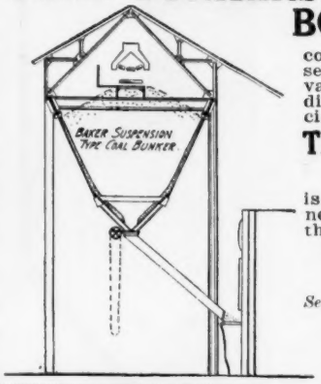
Write now for booklet explaining the new idea in this valve.

The Eynon-Evans Manufacturing Company

Main Office and Works: Philadelphia, Pa.

Oliver M. Simmons, 58 Sutter St., San Francisco, Cal.
E. J. Deckman, Oliver Bldg., Pittsburgh, Pa.
William F. Otto, 11 St. Clement St., Wilkes-Barre, Pa.
E. F. Walker, 170 Broadway, New York, N. Y.

COAL BUNKERS in the BOILER ROOM



combined with properly selected conveying and elevating machinery will pay dividends and increase efficiency.

The Baker Suspension Type Bunker

is the latest and most economical bin structure on the market.

Complete Coal and Ash Handling Plants
Designed and Built.

Send for Catalog. Write for prices.

Arthur G. McKee
Consulting Engineer
Cleveland, Ohio

Not a "Steam" Blower—but a TURBINE Blower

This little blower is cemented right in the boiler wall. Connect a steam line and you are ready. No space required.

Not a "steam-eater," but a steam-saver. Our invention, the Expanding Casing makes the

WING Turbine "Type E" Blower

The Individual Blower with the Efficiency of a Central Fan System.

Solid bronze turbine, supported between outboard dust-proof ball bearings, placed where steam can't touch them. Extra nozzle control for low pressures. And quiet operation. Our booklet tells all about it, and gives a lot of other interesting information. **Ask for Bulletin 17.**

L. J. Wing Mfg. Co.

9th Ave. and 14th St., New York

Manufacturers of Ventilating Fans, Blowers, Damper Regulators, Pressure Blowers, and Vacuum Pumps.

If You Use Calipers—Use a

Starrett

The Starrett calipers with the quick-adjusting, automatic-closing spring nut, save valuable time in opening and closing. The neatest handiest little tool you ever had. Send for our catalog No. 20AG and learn all about the other Starrett Tools.

The L. S. Starrett Co.
ATHOL, MASS.

42-50

For Your Power Plant

LEA-COURTENAY
Double Suction Turbine Pumps
Send for details.

Lea-Courtenay Co., 90 West St., N. Y.
Chicago Office: Otis Bldg.
Factory: Newark, N. J.
Also Mfgrs. of Jet Stokers and Forced Draft Systems.

Why Not Eliminate Priming?

REISERT

WATER SOFTENING APPARATUS

can be specially designed to meet your needs and to eliminate foaming and hard scale formation in your plant. Our methods include Lime, Soda Ash and Lime Barium treatments. **Write.**

REISERT AUTOMATIC WATER PURIFYING CO.
30 Church Street New York City